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School Science

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EDITORIAL

India's second satellite '*Bhaskara*' launched on 7 June 1979 is yet another achievement of Indian scientists in the field of space research. It is hoped that this satellite will help us to collect important data and to carryout experiments which will play a vital role in the launching of remote sensing satellites by Indian scientists in future.

Bhaskara has many salient features which were not present in the India's first satellite *Aryabhata*. To mention a few, it has components like pressure regulators, selenoid valves and relief valves to control its spin rate so that its TV Cameras are able to scan the earth in a series of overlapping picture frames. The satellite is also capable of orienting its spin axis along the normal to the orbit plane.

For better control during its spinning the spacecraft has also been provided with additional control elements. For operation of shutters of TV Camera, a horizontal crossing sensor is included to provide the pulse information as to when cameras are vertically looking down towards the earth.

The TV picture data would be received on earth through a high bit rate telemetry system at 91.39 kilobits per second in addition to the low bit rate telemetry at 224 bits per second that existed in *Aryabhata*

The uplink system of the spacecraft is of pseudorandom coding type which is again more advanced than that of *Aryabhata*. It has far more capability in terms of number of commands, to guard against spurious and false commands and flexibility for adoption to future missions.

Once the TV Cameras of *Bhaskara* are switched on, they will start taking the pictures of earth's surface both in visible and infrared range. Each photograph will cover an area of 340 sq. km and will provide resource information of interest in forestry, hydrology, geology and bio-mass. However, it has been reported on 26 June 1979 that the operations relating to the television system aboard *Bhaskara*, have been temporarily suspended owing to certain anomalies observed in the spacecraft's behaviours. The anomalies were observed when the first test of the TV Camera system was made on June 19 and 20 by switching on in turn the two cameras during *Bhaskara's* 180th and 195th orbit.

Bhaskara will also carry out experiments for measuring the microwave radiation emission from earth to yield data on soil moisture, ocean surface characteristics

and bio-mass features. The experiment will be carried out by utilizing the satellite microwave radiometer (SAMIR).

Bhaskara is a well known name in the history of science in India. In fact, India had produced two great mathematicians/astronomers by this name. To distinguish between the two they are usually referred as Bhaskara I (A.D. 600) and Bhaskara II (A.D. 1114). Thus by naming its second satellite as *Bhaskara*, India has remembered two of its great astronomers.

The work done by Bhaskara I is closely linked with that of Aryabhata after which the first Indian satellite was named. The three books written by Bhaskara I are *Mahabhaskariya*, *Laghubhaskariya* and a *bhasya* (commentary) on *Aryabhatia*, the later being the work of Aryabhata. *Mahabhaskariya* consists of eight chapters in which Bhaskara I has elaborated the three astronomical chapters of *Aryabhatia*. His work is ocassionally characterized by innovations and methods of his own. For example, he has given a new method called *pratyabda-sodhana* for finding out the mean latitude of planets, the *sighra* of venus and mercury and the perigee and node of moon. It is true that the rules for indeterminate analysis (*Kuttaka*) were given by Aryabhata but the credit of providing a comprehensive explanation of the method and its application to astronomy undoubtably, goes to Bhaskara I. Similarly the use of *manda karna* or hypotenuse to obtain correction in the formula for the equation of centre is another example of his originial thinking.

The *laghubhaskariya* is an abridged version of *Mahabhaskariya* which presents the same ideas in a more systematic form for the beginners. His *bhasya* is an elaborate and learned commentary on the famous work *Aryabhatia*.

Bhaskara II was born in A.D. 1114 in Vijapur in the province of Karnataka on Western Ghats. He wrote his famous book *Sidhanta-Siromani* in A.D. 1150 when he was only 36. The book is divided into four sections. The first two sections namely *Lilavati* and *Bijaganita* deal with arithmetic and algebra, respectively. The remaining two sections namely *Ganitadhyaya* and *Goladhyaya* have been devoted to astronomy. From the point of view of astronomy, *Goladhyaya* is perhaps most important document in which he has developed epicyclic-eccentric theories to account for planetary motion. Another important works of Bhaskara II are *Karana-Kutuhala* and *Vasanabhasya* the later being his own commentary to further explain and illustrate his own rules wherever he thought necessary.

In his works Bhaskara II has also given detailed descriptions about a number of astronomical instruments like water clocks, gnomons, *Cakra* or *Circle*, *Capa-Dhanu*, *Kartari*, *Turiya*, *Armillary sphere*, etc., which were frequently used in the study of astronomy for quite some time after his death.

R. Joshi

Jules Verne : The Founder of Modern Science Fiction

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THE name Jules Verne immediately takes the thoughts of elderly or middle-aged men of today to their childhood when they read his works as science fiction, but by the time they grew up that fiction element had already become stark reality. To the children of today, the day-to-day technological achievements are a reality but their reading of the works of a science fiction writer born 150 years ago would naturally arouse their astonishment at the accuracy and depth to which the prediction element could be introduced at an age when there was no concept of the modern scientific marvels. Indeed, in this light, Jules Verne can be considered to be the founder of modern science fiction and it is little surprise, therefore, that the publishing of his works is estimated to be the fourth largest in the world.

The phenomenal Jules Verne was born in Nantes, France, on 8 February 1828 in a well-to-do family from a comfortable social class. As was the vogue among families during his time, he continued his education in a Law School in Paris. However, his social contacts were numerous, including Alexandre Dumas. He also took up an assignment as Secretary for an organization which is presently known as the Paris Opera, and began his career as a music writer and playwright but this did not make him famous as such.

Jules Verne (1828-1905)

To him, ending up as the head of his father's solicitor's office seemed out of place and thus out of question for the future, too. Jules Verne was a hard worker. He, in his spare time, began to study geography, physics and mathematics, and entertained the thought of informing the public about how scientists worked. And this was revealed authentically in the vocabulary of his science fiction novels.

His natural penchant for story-telling caused him to take up his writing of science fiction novels as well as the study of research projects and techniques of his times. It was in 1858 that his first efforts took the form of travel stories published in magazines. Then, in 1867, his first successful novel *Five Weeks in a Balloon* (Voyage en Ballon) launched the

series his publisher entitled, *The Extraordinary Travels* (Voyages Extra Ordinaires). The second of this series was *Journey to the Centre of the Earth* (Voyage en Centre de la terre) appeared in 1864, which brought its author world fame and immediate popularity. Verne produced a new work of science fiction or adventure every year thereafter, ever increasing his following until his works were known all over the world and selling in the millions. Among his best selling novels are *From the Earth to the Moon, Around the World in Eighty Days, 20000 Leagues under the Sea, and The Mysterious Island.*

Verne's gift of prophecy was always based upon a sound scientific foundation, which has earned for him a lasting place in literature and science fiction. A nuclear submarine is now called the 'Nautilus' and his fantasies have been brought to reality when man has set foot on the moon and returned from it. There are other scientific and technological marvels which leave behind the wildest fancies of characters in his novels such as Nemo, the captain of the submarine Nautilus, Nadar, the photographer-aeronaut or of engineer Banks...

Studies and essays on Jules Verne are numerous. Among others, the following may be consulted :

(i) Allottee de la Fuye—Jules Verne (Hatchette, 1965)

(ii) Marcel More, Le Tre's Curieux Jules Verne

(iii) Nouvelles Explorations de Jules Verne (Gallimard)

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*The author is deeply grateful to the Director and staff of Alliance Francaise de Delhi for making available some written material which provides a background for the present write-up. □

R. V. N. M. HIGH SCHOOL (MAIN)
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Direct Generation of Electricity from the Sun

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SUNLIGHT is the primary source of energy for the sustenance of biological systems on the earth. Without the sun there would be no life. How is this tremendous amount of energy generated in the sun ?

There is a process known as thermonuclear fusion, by which light nuclei of atoms fuse together to form a heavier nucleus, generating, in the process, a large amount of energy. This process is almost the opposite of nuclear fission where an unstable heavy nucleus breaks up into smaller atoms releasing energy. The process of thermonuclear fusion has been going on in the sun from time immemorial and will perhaps go on for ever. In order to get an idea of the amount of energy generated in the sun, it is sufficient to say that the energy produced in only one second is more than the total energy used on the surface of the earth from the beginning of civilization. Only a very minute fraction of the total solar energy produced reaches the earth's surface, but even this amount is stupendous. If you collect the solar energy falling on a medium-sized football field (say, 100 m × 50 m) for only 7 seconds at noon time on a clear sunny day, it would be equivalent to one litre of petrol, or to 10 kilowatt hour of energy. A little calculation will show that the total solar energy falling on this football field on a clear sunny day is equivalent to more than 2.5 kilo litres of petrol. If one could convert this energy into some more useful and productive form. This is quite an exciting possibility, is it not ? But, can we really do such a thing ?

In order to answer this question, we have to have a closer look at the word 'energy.' What do we mean by energy ? Energy is the ability to do work. Depending on our needs and necessities, we use different forms of energy. When we eat food, our system stores bio-chemical energy, which our muscles use up. Burning fuel gives heat energy which can be converted into electrical energy. The solar energy is also available in various forms. We have direct heat or light energy from the sun, the wind energy, the geo-thermal energy, and we have indirect solar energy in the form of bio-gas, bio-mass, and fossil fuels. Our sun is really magnanimous in supplying us with so much energy in different forms, most of which we do not seem to utilize. This is because, in order to use this tremendous amount of energy, or even a fraction of it, we have to know how to convert it into more useful forms. It may be difficult, almost impossible, to convert the solar energy falling on our football field into petrol; but it is possible to convert that energy directly into electricity. Let us now begin the story of how solar energy can be directly converted into electricity.

How is Eletricity Generated ?

Electricity is usually generated by suitable conversion of motive power. We have seen how a dynamo works on a bicycle during the night. The rotor of the dynamo presses against the rear wheel of the bicycle and when the cycle moves, the rotor rotates, thus gene-

rating electricity which lights the headlight. In a very similar way, electrical energy is generated in centralised power stations by driving a turbine by means of some motive power. This motive power may be obtained either from stored potential energy, as in hydro-electric power stations, or from pressurised steam generated by heating, as in coal or oil-fired power stations. Since solar energy contains a large amount of heat energy, this can certainly be used suitably to produce high pressure steam to drive a turbine for the generation of electrical energy. However, that would be an indirect generation, because solar energy has to be converted first into steam energy, and then into electricity. In the direct generation of electricity from solar energy, one does not have to go through any intermediate driving of turbine. But is it really possible ? Yes, such a process is indeed available.

In order to understand the underlying principle of such a process, let us start with an analogy. Have you seen any of our hydro-electric power stations, say at Bhakra, Hirakud, Mython or at Nagarjunasagar ? How do they work ? The river water is stored at a higher level by suitable dams, and the electricity-generating turbines are driven by a controlled release of water. The waterfalling from a higher level loses potential energy and goes into generating the electricity. A similar process can take place in certain solids, known as 'semi-conductors.' When solar energy is incident on them, they generate excess current carriers at higher energy, at the expense of solar energy. If these oppositely charged carriers can be separated inside the solid, their movement will constitute an electric current, and hence that will generate electrical energy. The flow of these charge carriers is very similar to the flow of water in our hydro-electric stations.

It is nice to give an analogy and say that such things do happen in certain solids. But what exactly happens there ? What are semi-conductors ? In other words, what are the underlying physical processes involved ? Let us now try to answer all these questions.

Solar Cells and Photovoltaics

Semi-conductors are solids having certain physical properties in between those of insulators and conductors. Copper, silver, aluminium, gold, etc. are all conductors; and dry wood, plastics, glass, ceramics are all insulators. Silicon, which is the second most abundant element on the earth's crust after oxygen, is however a semi-conductor. The earth's crust contains approximately 23 per cent of silicon, mostly in the form of silica and sand, both of which are silicon dioxide. Other semi-conductors are germanium, cadmium sulphide, gallium aresenide, indium phosphide, etc. We will, however concentrate only on silicon, because of its abundance and wide use.

Impure silicon (of the order of 95 to 98 per cent purity) is widely used in steel and aluminium industries. However, semi-conducting silicon has to be extremely pure (99.999999 per cent), that is, the maximum impurity should be at the level of one part in one hundred million. Its electrical and electronic properties can be changed by suitably 'doping' or incorporating foreign elements in it. Thus, when one adds a controlled quantity of phosphorous or arsenide (VIth group elements of the periodic table) to highly pure silicon, it turns 'n-type', meaning thereby that its current carriers are negatively charged electrons ('n' standing for negative). Its resistivity or conductivity will depend on the amount of the foreign element added. Similarly, the addition of a controlled amount of boron or aluminium (IIIrd group elements of the periodic table)

Similarity between a hydro-electric power system and a solar cell

turns this semi-conductor 'p type' ('p' standing for positive), because the current carriers are positively charged 'holes'. If one section of an n-type silicon is doped with IIIrd group element in excess of the background negative electrons, then that section will become p-type. Thus, there will be a physical junction formed between the two sections, which is known as the 'p—n junction'. This p—n junction forms the basis of the almost all semi-conductor devices.

The p—n junction, thus formed, introduces a potential barrier between the two sections. This is very similar to the man-made dam of our hydro-electric stations. In order to visualise the analogy deeper, we have to remember another important property of semi-conductors. Unlike in conducting metals, excess current carriers can be either generated or injected in semi-conductors. When the sun shines on such a device, excess electron-hole pairs are generated, their number depending on the intensity of the incident solar energy. Because of the built-in potential barrier at the p—n junction, these generated charge carriers get separated from each other. Positively charged holes, generated in the n-type material, and negatively charged electrons, generated in the p-type material, move towards the p—n junction. The flow of each type of carriers constitutes an electronic current. The flow of charged carriers takes place across the potential barrier in both the directions, unlike the uni-directional water flow through the dam of our hydro-electronic station. If this p—n junction device is connected to a load, such as an electric bulb or a resistance, the internal flow of charge carriers across the barrier results in the supply of electrical energy to the external circuit. We can now see the dam analogy in a better way. Just as the rain in the catchment area replenishes the river water in the hydro-elecctric station, solar energy continuously generates excess charge carriers inside the material. The downward flow of water drives the turbine and generates electricity. Similarly, the flow of the excess charge carriers across the p—n junction generates electrical energy. However, there is one major difference between the two processes, apart from the moving turbine involved in the generation of hydel power. We can store the water at the higher level as long as we wish, and use it on'y when necessary. But, we cannot store the excesss charge carriers inside the semi-conductor materials because oppositely charged carriers recombine very fast. Thus, we can generate electrical energy in this device, known as the 'solar cell', as long as the sun shines on it but we cannot store the electrical energy in it. The generated electricity must be immediately used, or, else, stored in conventional storage batteries. This process of electricity generation from solar energy using solar cells is known as 'solar photovoltaic' generation.

How Solar Cells are Made?

The various process steps involved in the fabrication of a solar cell are explained in Fig. 1. At first, the p—n junction is formed on a thin slice (0.3 mm) of silicon. The p-side of the silicon material is completely covered with some suitable metallic contact. This side remains away from the incident solar energy. The other side, that is the n-type surface which faces the incident solar energy, is partially covered with metallic contact in the form of fingers. This is shown in Fig. 2. The reason for using this fingered pattern is very simple. Solar energy, absorbed only on the silicon surface, generates electrical energy. Whatever solar energy is incident on the metallic contact fingers, does not generate any electricity. And, yet, we need the metallic contact to tap the generated electrical energy with minimum resistance. So, we have to carefully design the metallic contact fingers in such a way that

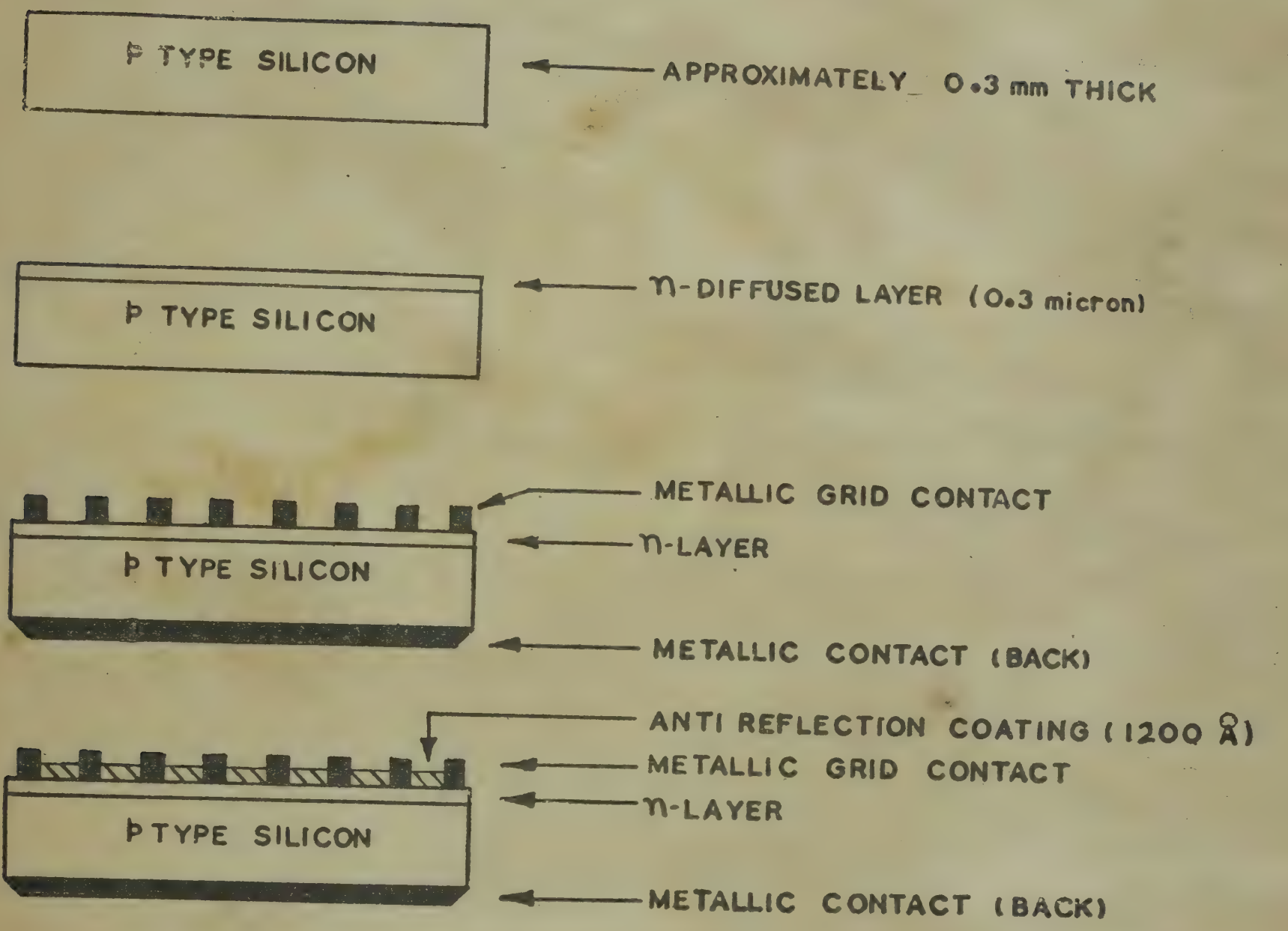

FIG. 1 FABRICATION OF A SOLAR CELL

minimum area is lost due to them, and yet the electrical resistance of the solar cell is minimum. It must be remembered here that whatever has been said above about the roles of p- and n-types, can suitably be interchanged, depending on the technical requirement. But, on whichever side the metal fingers are, the p-side is always the positive terminal and the n-side the negative terminal of the solar cell.

Normally, polished silicon surface reflects about 36 per cent of the incident solar energy. This means that we are losing about one-third of the incident solar energy by reflection, which could possibly be used to produce electricity. To reduce this reflection, an extremely thin (about 1200 A) transparent oxide of some suitable element is deposited on the active surface. The refractive index and thick-

ness of this oxide are such that it produces what is known as, an 'anti-reflection coating' on the surface of the solar cell. The net effect of this coating is that the silicon surface looks deep blue, instead of its shiny metallic colour. This reduces the reflectivity of the solar cell surface drastically from 36 per cent to only 4 to 6 per cent.

But, is all the incident solar energy fully converted into electricity ? Unfortunately, the answer is, no. The reason for various losses inside the solar cell, during the conversion process, is fairly complicated. Quantum mechanical calculations show that the maximum conversion efficiency possible with silicon p—n junction solar cells is only 21-22 per cent. In fact, experimentally so far, a maximum of only 19 per cent conversion efficiency has been obtained in laboratory with silicon p—n junction solar cells. However, when

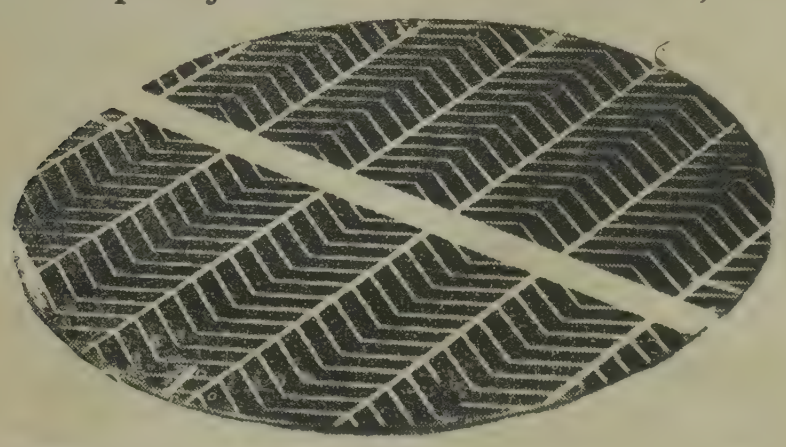

Fig. 2. *Front metallic grid structure of a Solar Cell*

these cells are manufactured in large quantities, a conversion efficiency ranging between 10 to 16 per cent is more common. Of course, there are other semi-conductor materials which give larger efficiency than silicon as solar cells. But then, they are not as easily available as is silicon and their costs are relatively higher.

Solar Cell Modules

Solar cells are made in various sizes, ranging in area up to about 100 sq. cm. They can be square, circular or hexagonal in shape. The square and hexagonal solar cells can be packed together side by side very closely, but there will be a lot of empty space when the circular cells are packed. You must be wondering why we are talking about packing these cells side by side. Let us try to understand that. When a silicon solar cell is made by the process described above, it will generate electricity when the sun shines on it. But the question is, how much voltage and how much current are generated ? The voltage generated in the cell does not depend at all on the area of the cell. This voltage is approximately 0.5 volt per cell, irrespective of the area, and it does not depend much on the amount of the incident solar energy. However, the generated current is directly proportional to both the area of the cell and the amount of the incident energy. Thus, a larger-area cell will generate more current at the same voltage than a smaller-area cell under the same incident energy. The generated current will go on varying from sunrise to sunset on a clear sunny day reaching a maximum around noon time. Its generated voltage will vary little during this period. The generated current in a silicon solar cell is somewhere between 30 to 40 milli ampere per sq. cm. of active area, on a clear sunny day around noon time. But the question still remains, how do we actually use these cells in order to utilise the electricity generated ? As we know, most of our electrical equipments or gadgets require 3, 6, 12, 24, 110 or 220 volts. The 110 and 220 volt gadgets usually are operated on alternating current. The solar cells produce direct current, and so we will talk only of direct-current-operated instruments and gadgets. In order to get higher voltages, the solar cells are connected in series, because then the individual cell voltages add up. Thus, to operate a device on 3 volts, we need at least six cells (actually eight, due to various other

considerations) to be connected in series. What determines the area of the individual cells ? If we want to operate a 3 volt torchlight which requires 200 milli ampere current, then the minimum area of each cell has been calculated to be about 6 cm^2. So, if we have a string of eight cells, each of 6 cm^2, connected in series (positive of one cell connected to the negative of the next cell, and so on), then we can light the torchlight in a sunny mid-day. Of course, the torchlight will get dimmer and dimmer as the day passes, because the generated current will go on decreasing after noon time. Each such string is known as a photovoltaic 'module.' If we want more current, we can connect two or any number of similar modules in parallel (positive terminals of all modules are connected together, and so are the negative terminals separately). Various such modules are shown in Fig. 3.

But what is the use of lighting a torchlight during the day time ? We need it during the night. In order to use the generated electrical energy at a time we need, we have to store the electricity in suitabale batteries. Rechargeable storage batteries can be charged during the

Fig. 3. *Solar Photovoltaic modules for various applications*

sunshine hours, and these can be used to light torchlight during the night. In fact, because the generated electricity in the solar cell module goes on varying from sunrise to sunset, it is preferable to store the electricity in rechargeable batteries for its optimum and effective use.

Solar Photovoltaic Systems

Solar cells were invented in the USA, in 1954 Although they were very expensive, they found an immediate use in the weather and communication satellites, because there was no other source of electricity available to them. Even today, for reliable and efficient use in these space-ships, solar cells are the only means of supplying electricity in the wide open space. In fact, thousands of spacecrafts are equipped with these highly reliable solar photovoltaic modules. These photovoltaic modules have been supplying the necessary electrical energy to all the electronic equipmemts in these spacecrafts for dacades.

However, the increasing worldwide shortage of fossil fuels and coal for the generation of energy for human use has diverted the attention of scientists and engineers all over the world to solar photovoltaic electricity generating units, amongst others. Of course, these photovoltaic systems are still extremely expensive and cannot be used on a wide scale. However, extensive work is in progress all over the world to reduce the cost, so as to make these systems usable.

The greatest advantages of these energy sources are their decentralized nature and independence from any fast-depleting material fuel, such as coal and fossil fuel. Today's electricity generating stations produce electricity at a centralized location, and then that electricity is distributed to various consumers by means of an extensive grid. On the other hand, photovoltaic electricity can be generated and used at the location of need, and there is no need to distribute it, because the solar

energy itself is well distributed. Therefore, ideally, each house can have its own photovoltaic modules and storage systems to supply electricity to fans, television sets, radios, water pumps and all electrical equipments. Even if there is no sunlight continuously for a few days, which is not so common in India, the storage system will take care of the energy supply. Of course, all this is under an ideal situation, a situation which has not yet come. There are a number of hurdles in the achievement of such an ideal situation, the primary one being the cost of these systems. Nevertheless, human intelligence is unlimited, and the mass use of fuel-free solar photovoltaic electrical energy sources is at best a matter of time. The day is not very far off when the mighty sun will step down from its imperial pedestal and bow its head to the ingenuity of mankind. □

When Disaster Strikes

JOHN RIVERS and ANDREA BARON
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When a large community or population is struck by an earthquake, floods or famine, it is often difficult to make decisions on the form relief should take and how it should be organized to do the most good. Scientists could provide great deal of information that might prove invaluable in such events.

CYNICS may feel that the International Disasters Institute, set up in London in 1978 to study the application of science and technology to disasters in developing countries, is a luxury the world cannot afford. They may argue that there are already far too many such organizations, far too many attempts to introduce science and technology into everything, and that, in any case, London is too far from the problems of disaster-prone developing countries. In what way, then, is such an institute relevant to the real problems of disasters ?

THE IDI has evolved primarily from a research group called the London Technical Group. This grew out of the coming together, at the time of the Bangladesh cyclone nearly a decade ago, of a group of young scientists who believed that, since science had played a big part in helping people to kill one another more effectively in wars, it should, and could, be equally affective in helping to save lives. Their conviction that science could be useful in mitigating disasters was based upon a consideration of the nature of disasters themselves.

Impact

In general, most large-scale disasters occur in developing countries. This is not only because they happen to be in naturally disaster-prone areas, such as those of high earthquake risk. Sudden catastrophes, including earthquakes and floods, also happen in developed countries, though more rarely. But when they do, their impact is cushioned because large sums of money are available to deal with them. Examples of this are the cyclone which struck Darwin in North Australia in 1976, and the Aberfan coal-tip disaster in the U.K. Tragic though it was that many children died in the latter, the size of the rescue operation and the amounts of money raised in the aftermath of the disaster were out of all proportion to its scale, if we were to take funds available in developing countries as the norm.

In the U.K. tremendous effort is now being put into contingency plans against the possibility of the River Thames flooding. But in developing countries, a lack of money means both a lack of pre-disaster planning and that the effect of a catastrophe will be much more far reaching in terms of loss of life and property and social breakdown, and often a point is reached, at an early stage, where relief efforts cannot cope with a continuously deteriorating situation.

So although disasters may often result from natural causes beyond our control, the conditions which follow them could often be avoided if enough money were available. And if money is in short supply, the question of how to spend it wisely is crucial.

Often, the wisest course to follow is obvious to all, but the original founders of IDI believed, and still believe, that there are many areas of disaster relief in which scientific expertise is necessary to determine how the available resources should be allocated. An example of this can be seen if we consider the problem of large-scale vaccination programmes. Where vaccine supplies are short it is impossible to vaccinate everybody at risk and if a small proportion of the population are vaccinated at random an epidemic cannot be controlled. The best way to use the available supplies is to keep the whole risk area under surveillance for epidemics and to attack outbreaks by intensive vaccination programmes in those areas where they occure, thereby containing the epidemic. It is pointless, too, to send vitamin supplements without having some previous knowledge of what vitamin deficiencies are already to be found in the affected population; such deficiencies appear gradually and are likely to cause disease only after long periods of deprivation. In the meantime, people may be dying from starvation.

Illness

Other areas in which medical aid needs scientific information are in deciding what to include in medical kits, or even in deciding what illness has to be dealt with. For instance, nuns in a refugee camp in Bangladesh at the time of the 1970 cyclone were treating cases of goitre while other people in the camp were dying from gastro-enteritis. At the time of a disaster, 'illness' becomes a relative term which may cease to apply to a problem such as goitre.

Where there are not enough funds, certain difficult decisions may have to be made which are sometimes a matter of life or death to those who need help. And, of course, neither scientists nor outside relief organizations can make these decisions. It is up to the country itself. But organizations such as IDI can help by examining the issues and making available some of the information that would help those who have to decide.

Problems of famine relief would seem to be quite straightforward : the need appears to be to provide food for hungry people. Yet, paradoxically, there is often enough food to go round ; the problem is that people do not have the money to buy it. This may be, as in southern Ethiopia, because a local drought has caused livestock to die which would otherwise have been sold to buy cereals, which normally provided the bulk of the food supply. So food, which tends in any case to take too long to arrive, may be less useful than money. Clearly, effective famine relief requires a fuller understanding of the complexities that we meet. More scientific investigation is needed in this, and in other areas. The main aim of IDI is to promote such research, because it believes that it will save lives.

Programmes

There is another, wider purpose in compiling information about disasters. They are not simply isolated phenomena that come and go, leaving no legacy. Indeed, an awareness of probable future disasters should be built in to all planning, for history teaches us that such factors are inextricably bound up in the development of a nation. For example, the Irish famine caused massive emigration of the peasant population and had far reaching and

long-lasting effects on Ireland's future.

The IDI exists to encourage research that will further our understanding of disasters in all the ways we have mentioned, involving inquiry into their causes, their natures and their wider implications. It also aims to make available, to governments and relief agencies, information ranging from specific scientific data about nutrition or disease to sociological or economic studies.

But why is such an Institute based in London ? This can be justified on two counts. First, although London is remote from the scenes of most of the disasters we have mentioned, it is a centre for many relief organizations and a great deal of IDI's work involves trying to provide the information that will help aid agencies to use their limited resources as effectively as possible. Second, linked as it is historically and through the Commonwealth with many developing nations, London contains an abundance of institutions which can help to provide relevant information : places such as the School of Oriental and African Studies, the Royal Geographical Society and the London School of Hygiene and Tropical Medicine. Indeed, at the time of the Lice earthquake in Turkey in 1975, the London Technical Group, IDI's parent body, was able to compile a comprehensive report, in a few days, that gave more details of affected areas, and of the likely social, geographical and economic constraints on relief operations, than could have been obtained in Lice itself. □

The Water Decade 1981-1990

IAIN GUEST

ASK someone from an affluent city suburb to characterize water and you would probably get a curious stare and something along the lines of "colourless, tasteless and abundant." But ask the same question to a villager in the Third World, and the answer might well provide a web of insights into a life of extraordinary hardship. For here water does not come from the ubiquitous tap. It has to be carried—usually by women—from a well or a river up to a mile away, several times a day. It is usually insufficient, and what there is may be so badly contaminated that it risks causing severe diarrhoea.

The fact that safe drinking water and its corollary, proper sanitation, are taken for granted in the more affluent countries but are a matter of life and death in the developing world has been monitored with increasing concern by WHO in recent years. This concern expressed itself in the UN agencies' own way of generating a sense of political urgency—the large international conference.

The Habitat Conference, held in Vancouver in 1976, stated as a goal—"fresh water for all by 1990." The UN Water Conference, at Mar del Plata, Argentina, in 1977, made this more specific and designated the period 1981-1990 as the International Water Supply and Sanitation Decade, while 1978-1980 would be the years for collecting data and evaluating the dimension of the crisis.

Thirdly, the 1978 Alma-Ata Conference on Primary Health Care spelt out in broad outline some of the ways and means of incorporating the decade into a new two-part strategy for health : more "relevant" health services, and more emphasis on preventive health with all-round social and economic development.

Sanitation is closely related to drinking water Iindeed the rows of defecating children that are a common sight in much of the Third World are a more dramatic reminder of the problem than the absence of fresh water. Several studies have stressed that providing only safe drinking water or only facilities for disposing of excreta without the other half of the solution will be unlikely to lead to an improvement.

How serious is the crisis ? WHO carries out regular surveys on the coverage of community water supply and excreta disposal services in the developing countries. The most recent, published in 1975, found some 1,230 million people without adequate water supply and 1,350 million without sanitation. More specifically, by the end of 1975 the total population of the developing world, excluding China, was roughly 2,000 million people; of these, 70 per cent lived in the rural areas and the rest in cities. While 57 per cent of the city population had access to community water through house connections, and another 21 per cent through public standposts, in the rural areas only 22 per cent had access. A total of 38 per cent of the Third World's population had access to safe drinking water.

In the cities, 25 per cent of the population had house connections to sewerage systems and an additional 50 per cent were served by household systems. In the rural areas, only 15 per cent had any access to sanitary latrines. Of the total number of people estimated to be

without these most essential of services,, more than 700 million are children—an important and alarming figure, particulary as 1979 has been designated International Year of the Child.

The first consequence of the lack is disease, WHO estimates that as much as 80 per cent of all disease in the world is associated with water. It can take several forms. Firstly, there are germs ingested through drinking contaminated water : these cause typhoid, gastro-enteritis, cholera. Then, communicable diseases such as scabies and trachoma, transmission of which is favoured by chronic water shortage, or poor quality of water. Thirdly, disease caused by parasites that inhabit water and burrow through the skin—like schistosomiasis, which is carried by snails, or dracunculinsis, carried by the guinea worm. Finally there are the carriers (vectors) of disease which breed in bodies of water. The most serious of these are mosquitos, responsible for the current alarming upsurge of malaria, and the flies which cause river blindness (onchocerciasis).

In round figures an astonishing number of people suffer from these water-related diseases at any one time : 400 million with gastro-enteritis, 160 million with malaria, 30 million with river blindness, 200 million with schistosomiasis.

This connection between the lack of clean, piped water and disease is now well established. In one case, in a cholera outbreak in the Mulange district of Malawi, the families who escaped the disease were those with piped water which, though untreated, was coming from upstream and was therefore uncontaminated. Those who suffered were those without piped water.

WHO surveys have noted another characteristic of fresh water—it comes with money. One 1970 survey found that in countries with a per capita income of less than US $ 110 a year, over 80 per cent of the population still lacked excreta disposal services and fresh water. For most countries with incomes within the range of $ 110 and $ 1000 the proportion is considerably smaller and ranges from 20 to 70 per cent.

Within countries, the disparity in services between urban and rural areas is often accounted for by the higher income of town dwellers, and their ability to apply greater political pressure in order to get services. Slums, however, stand out as an important exception—particulary since they are excepted to expand dramatically in the next 14 years.

In a limited sense the situation is improving. WHO's 1975 mid-decade survey showed that the number of urban dwellers servived by drinking water had increased from 316 million in 1970 to 450 million in 1975 from 67 to 77 per cent. In rural areas, the increase was from 182 million to 313 million—14 to 22 per cent. For excreta disposal, the increase was from 71 to 75 per cent in urban areas, and from 11 to 15 per cent in the countryside. But this is still far below rate of increase called for by the International Decade. In addition, the UN Fund for Population Activities (UNFPA) estimates that, irrespective of the success of family planning, the world's population is certain to double by the end of the century.

Furthermore, bare statistics can be falsely optimistic or may mask deficiencies. No water system can be entirely leakproof, even in an advanced industrialized country. Where water can leak, contamination can enter. In a survey of 401 cities in the United States, two researchers found that in one out of ten cities, 25 per cent of the water was being lost. As with food lost during storage from rodents, water lost from leaky pipes in the developing world can amount to as much as 50 per cent.

The water supply is often intermittent. This is serious, because when the pressure falls off

Plentiful supplies of clean water save lives, particularly among babies, as well as making life easier for women

there is no resistance to the intrusion of pollutants from the outside. An estimated 27 per cent of the water supplies in Africa, south of the Sahera, are intermittent, and as much as 91 per cent of the water supplies in South-East Asia. Again many cities employ two systems of water—one safe for drinking and the other for washing streets and watering gardens. When they run side by side, there is a serious risk of contamination.

The 1981-1990 water decade concerns only safe drinking water and sanitation. It does not directly concern water management, which was discussed during the Desertification Conference held in Nairobi in 1977, nor the challenge of increasing and mobilizing water resources so as to meet food requirements. But clearly, all are interconnected, and it will be one of the aims of the decade to stress this.

Malnutrition and a lack of fresh water are interrelated. Malnutrition undermines the individual's resistance to such diseases as diarrhoea. Diarrhoea itself further reduces the intake of food and causes loss of body fluids, resulting the further malnutrition. Just as the need for food is greatest in the developing countries, so is the need for water : in a dry climate the body requires, on average, up to twice as much

water (5 litres) a day.

The Mar del Plata Conference in Argentina called for an unparalleled effort to be made by governments and the international community—a call that was reiterated by last year's WHO/UNICEF Conference on Primary Health Care held at Alma-Ata in Soviet Kazakhstan. In a joint report to the Conference, the heads of the two agencies noted that "Plentiful supplies of clean water help to decrease mortality and morbidity, in particular among infants and children, as well as making life easier for women. Countrywide plans are required to bring urban and rural water supplies within easy reach of the majority in the shortest possible time."

That conference ended with 22 recommendations and the Declaration of Alma-Ata. In broad terms, these said that the best form of preventive health care is social and economic development. They stressed the need for increased investment, and underlined that the form of technology and manpower to be involved must be relevant to the needs and resources of the countries involved.

Of course, this is more easily said than done, as with all conferences clarion-calls. What are the obstacles ? In 1970, 88 countries were asked precisely this question in a WHO survey. The replies were illuminating ; 48 gave lack of internal finances as the first problem ; 10 cited the lack of external resources, 11 said they lacked a proper administrative structure, and 19 said the chief concern was the lack of trained personnel. It is not hard to see why money looms so large. Between 1970 and 1975 the amount invested on water throughout the world were on average $ 67 per person in urban areas and $ 17 in rural areas.

The World Bank and WHO reported to the Mar del Plata Conference that $ 1,40,000 million would be needed to reach the target of "clean water for all by 1990." For this to be achieved, investment on water supplies in urban areas would have to be increased one-and-a-half times and in rural areas four times, while eight times as much would have to be spent on sanitation.

Where will it come from ? On past performance, from the countries themselves. External aid from donors in the industrialized world has been falling behind the two targets set by the UN : one per cent of all net flows, or 0.7 per cent of the GNP for official development assistance. In 1970, net aid from the 17 Western member-countries of the Development Assistance Committee (DAC) was $ 17,400 million instead of the target of $ 22,000 million. Of the money invested on water in 1971, only 12 per cent in urban areas was met by aid and nine per cent in rural areas. In the same year, $ 710 million of aid went to community water and $ 142 million to sanitation. But even these figures disguise the fact that more than half the aid went to Latin America, and only two per cent to South-East Asia, where the need is even greater.

It is not, of course, simply a question of money. It is a question of political will and priorities. The Alma-Ata Declaration talks of the need to involve the community—almost a catch-phrase by now, but essential if the water decade targets are to be met. Community development starts with the family. Since women are usually the carriers of water, and often control the family's hygiene and health, they are the first obvious target. In Kenya, for instance, the Women's Associations are actively promoting basic family health and sanitation. Third World mothers cope marvellously well with their family health in trying circumstances, but they probably need to be told about the benefits of fresh water and sanitation. They may not be aware that diarrhoea (which, according to the 1975 World Bank report, was the leading identifiable cause

of death in Paraguay, Guatemala, and El Salvador) can be cured by administering a simple sugar and salt solution to replace lost body fluids, and that there is no need for expensive drip treatment in hospitals. Again, people may have to be encouraged to act together to construct a simple tubewell pump, since the only pumps in operation may have been owned by rich farmers.

"Community development" implies appropriate tools or technology—another catchphrase. But the acid test of technology is whether villagers will in fact use it. Well-meaning aid programmes have introduced latrines into villages, only to find that they are not used, because they are malodorous, have to be emptied, are uncomfortable to use, and draw public attention to a bodily function which many prefer to perform at night.

The British development agency OXFAM has designated a latrine currently in use in Viet Nam as one of the best available in the Third World. It cuts down disease, and also turns human excreta into organic manure, producing some 6,00,000 tons a year. After 45 days, when the excreta has been rendered bacteria free, it can be removed from a hole in the back of the latrine. In the Republic of Korea, human excreta is turned into methane gas, for use in 50,000 rural households.

One reason why the community should be involved from the earliest time in decision-making is the problem of maintaining pumps and latrines. These services, in fact, again raise the dilemma—who should pay ? WHO's policy is in general that the communities should share the costs, partly in order to increase their sense of responsibility. And yet, having the poorest pay for the services which should ideally be free seems to be a contradiction.

This problem had to be overcome in one of UNICEF's most successful programmes—to install tubewells in Bangladesh, a country where more than 60 per cent of all disease is caused by polluted water. Bangladesh is peculiarly vulnerable. It is washed by three huge rivers and in the monsoons 70 per cent of the country lies under water. Too much water means flooding, yet too little means drought. And because the country is so flat, there is no possibility of preserving the water for use in the dry season.

Changing Priorities

In most countries at the most senior level—the government—it is not so much a question of the amount of money as a question of priorities. Even though the benefits stemming from having a healthy population are now well-established, it is as difficult for a government to direct sanitation and water services towards the poor as it is to change health priorities from city-based hospitals to rural health centres. Their difficulties may increase if government economists regard such services as "pouring good money after bad", and suspect that "community development" is another way of saying they will have no further control over how the money is used.

Then there are the problems of administration. Whose responsibility is water—that of the health ministry or of agriculture, or of a separate department ? If water is going to be shared by several ministries, there will clearly be problems of coordination. But if it is going to be under a separate administration, other concerned ministries may well argue that they should no longer be involved. Yet most countries which have rated water and sanitation a priority are setting up separate administrative systems.

One fact stands out: where governments have committed themselves to the objectives of the Water Decade, particularly with the active

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collaboration of village communities, improvements have been substantial. In the Domicican Republic in 1961, 43 per cent of the urban, and 83 per cent of the rural population lacked safe drinking water. The government set up a National Drinking Water Institute and the situation began to improve. "There was no single factor involved," says one WHO official, "It had a proper institutional structure; proper training of staff; built-in flexibility: cooperation between ministries and coordination of resources; tight technical supervision; dynamic community organization."

Similarly, Brazil has created a national sanitation plan and the National Housing Bank has been given the task of providing funds. The target is to provide 80 per cent of running water for the urban population by 1980.

In the old crowded streets of Ibadan, Nigeria, a "family group" of between 100 and 1,000 people makes an application to the Ibadan sewerage authority, and undertakes to provide land, labour, and running costs. The government then constructs "conform stations", with one toilet and shower for every 25 people.

But governments by themselves can not be expected to carry the burden of increased investment. Part of the contribution to the Water Decade from international agencies will take the form of greater coordination. With WHO and the UN Development Programme taking the lead, collaborative action will involve the World Bank, UNICEF, the Food and Agriculture Organization, the UN and the ILO. This in turn will seek to mobilize external cooperation for the Decade from bilateral and multilateral agencies. Within each country the UNDP resident representative will coordinate the needs. Each agency will continue to perform its special function, but the net results will be a much greater degree of coordination.

One other important form of cooperation was recommended by the Mar del Plata Conference, and that was regional cooperation. This will take the form of strengthening the water commissions in the various regional UN economic commissions, and also making greater efforts to share common water.

Whether such sharing actually happens could determine whether governments have the will to make the Water Decade a reality. Countries downstream argue that they are at the mercy of those upstream, which can turn valuable water on and off at will (by closing dam sluices), or may cause pollution and contamination which is beyond their control. Countries upstream argue that they cannot be constrained by considerations outside their own frontiers. Agreements such as that between Bangladesh and India over the Farraka Dam across the Ganges or between Brazil and Paraguay over the Parana River, suggest that international cooperation is indeed possible. □

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COURTSEY : WHO

Circular Form of Periodic Table

M. K. Sharda and D. C. Jain

Many types of periodic tables have been developed for the purpose of classifying into groups the elements with somewhat similar properties. The development of these tables results in the formation of Periodic Law. The 'Circular form of periodic table', as shown in the figure, is also a representation of the 'long form of periodic table.' This table is prepared keeping in view the idea of clear and easy approach to remember and reproduce.

Explanations

1. Each circle represents a period.
2. 'H' in the centre shows the unique position of Hydrogen.
3. Each period starts from 'S' block and ends at 'O' group in the same circle and the next period starts from the next circle in continuation.
4. The second circle starts from Helium which represents the first period.
5. Vertical columns represent the subsequent groups.
6. Elements are classified on the basis of electronic configuration and demarked as 'S' block, 'D' block, 'P' block, and zero.
7. Incomplete circles at the top represent the elements of Lanthanide and Actinide series.

Some New Findings

1. The size of the atomic radii increases as the size of the vertical column increases.
2. As explained by Bohr, in the structure of Atom, ionization energy decreases as electrons move away from the nucleus. Similarly, in this representation the position of the elements in a group away from the centre exhibits decrease in ionization energy.
3. This representation has zero group in the centre and the arrangement of elements in the clockwise manner provides the continuity of elements.
4. The unique position of Hydrogen in the centre exhibits its unique properties due to the extremely small size of Hydrogen atom.

Conclusion

Thus, we can conclude that this representation of periodic table is handy and has more utility in the teaching of chemistry as a subject. We need different types of periodic tables to explain atomic radii, ionization energy, electronegativity of elements, metallic character of elements and atomic volume. This representation alone can explain the above-mentioned properties in a nutshell than the extended form of periodic table.

For Example :

1. The metallic character of elements increases with the increase in size of the vertical column.
2. In accordance with the distance of the element from the centre, its size increases and the tendency to attract the electrons decreases. Therefore, electro-

negativity decreases in a group as size of the vertical column increases.

3. The valency of elements depends upon the number of electrons lost or gained in combination to acquire inert gas configuration.

Zero group in this representation explains the valency more clearly as

$F_{(9)}$ ($1s^2$, $2s^2$, $2p^5$)—VII A group member has more probability to aquire $Ne_{(10)}$ ($1s^2$, $2s^2$, $2p^6$) a zero group member. $Na_{(11)}$ ($1s^2$, $2s^2$, $2p^6$, $3s^1$), member of the first group has more probability to loose an electron, so as to acquire Ne_{10} configuration. So the valency change becomes more clear, viz.

Groups	VII A	Zero	I A
Valency	1	0	1
Elements	F	Ne	Na

We hope that our efforts will definitely improve the teaching of chemistry and we will welcome suggestions for further improvement. □

Developing Science Concepts in Children

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CONCEPTS in science are no doubt related to the facts; but, concepts are not merely a collection of organized facts. Popularly, concepts are described as generalised ideas. The child who has formed concepts, with sufficient clarity and adequacy is in a position to learn more advanced concepts with minimal effort. Therefore, concepts may be considered as mental constructs which help in the functioning of the mind at different levels with reference to cognitive, affective and psycho-motor learnings.

Concept-learning itself appears as a slow process as it takes time for the concepts to get formed in the mind. Several behaviours, such as seeing relationships, classifying, analysing, reasoning, discriminating, infering, synthesising and evaluating are involved in this process of learning.

When many related concepts are learnt by the child, there seems to be an association developed in the mind between those, resulting in the formation of 'concept-complexes' or 'conceptual themes.' For example, in biology, the conceptual theme 'genetic continuity' may be formed when concepts of DNA, gene, inheritance of characters, heredity and environment are learnt. A teacher who has formed conceptual themes is in a better position to communicate with his fellow teachers through an understandable technical language. The ease and fluency of communication from a concept base in the mind of the teacher helps in situations where there is interaction between him and the learner.

The very nature of science is such that it lends itself easily for a teacher to plan for 'concept-learnings.' The teacher may have to identify the concepts and sequence them in a hierarchy as he visualises the development of the lessons. The challenge for the teacher is *to develop the concepts* and not to tell the concepts one by one in the class. The explanatory approach adopted by many teachers kills scientific thinking, whereas the enquiry approach facilitates concept development in the sciences.

It is very essential that the teachers should be exposed to 'demonstration lessons' depicting concept development. The teachers should actually observe how learning-experiences are structured for children to enable them to develop concepts. Learning-experiences may be formulated around specimens, charts, diagrams, problems, experiments, analogies and models and also studies made by scientists with the help of appropriate questions based on the expected outcomes of learning. The in-built evaluational techniques would help the teacher to monitor concept development.

As there is rapid growth in terms of scientific knowledge, it is very necessary for the teacher to develop in the students the basic concepts which are acceptable to the present-day practising scientists in a particular field. The teachers ought to take care of this aspect. If not, the children are bewildered when the teachers at higher stages point out the faulty concepts learnt by them at lower stages in schools. A science newsletter published monthly by an academic body concerned with school science education in a state, may be an

answer to keep the teachers abreast of the recent developments in certain areas of the sciences prescribed for study. An example may illustrate this better. The concept of gene that was held about 50 years back has undergone a number of modifications. In the 1960s and later in the 1970s, the gene concept was revolutionised. Today, we are talking about genetic engineering.

The concepts developed in schools, specially at the higher secondary stage, ought to reflect the structure of the discipline. For example, many concepts in the area of photosynthesis may be developed in such a way as to depict the *molecular*, *cellular*, *organismic* and *ecological* approaches inherent in the discipline of life sciences. It would be quite interesting to record that when an attempt is made to develop concepts at the molecular/cellular levels, there would be a breakdown of the seemingly existing frontiers between the sister disciplines. The concepts developed in this manner could be a firm base for further strengthening and enrichment at the B.Sc. and M.Sc. degree courses in life sciences for those who pursue higher education.

In developing science concepts in the minds of young children, the teacher should also cater to the 'open-endedness' of the *disciplines*. Several problems based on the content may be identified by the teacher and he may encourage the children to design investigatory projects and try them out at school or preferably at home. Parents would be delighted to be co-learners in the fascinating process of enquiry when a simple open-ended experiment is done by the child at home.

Recently, two workshops were conducted by the NCERT and SCERT, Madras, to help the selected teachers in Karur and Pudukottai to plan simple investigatory projects in the sciences. The designs were tried out in the school laboratories. Among the many interesting projects developed, one was a study of the effect of anacin, codopyrin, digin and novalgin on the rooting in onion bulbs. One set of bulbs was exposed to continuous artificial illumination, and another set to total darkness. Preliminary data were obtained on the initial try-out. Several questions were raised by the teachers for further study. The concepts related to growth promotors and inhibitors were literally opened up.

Many teachers may wonder, how to complete the portions prescribed for an academic year if concepts are developed in the classroom. The teacher may have a pleasant surprise to record that when he develops concepts in the classroom, the children come prepared in advance with the relevant facts gathered from the prescribed textbook and when he tells the facts (information) from the textbook, the children do not come prepared for the class for obvious reasons.

Utilising some of the ideas discussed above, an attempt is made to plan for appropriate teaching strategies for developing the concept of photosynthesis at the higher secondary stage in our schools.

TEACHING PHOTOSYNTHESIS IN STANDARD XI

Class : XI UNIT : Photosynthesis

Textbook refrence

Biology, Volume II (Higher Secondary : First year), Tamilnadu Textbook Society, Madras, pages 81 to 87.

Note

(i) Lesson-plans are *not* developed here under.

(ii) *No* method is suggested for the teacher.

It is for *the teacher* to adopt an appropriate method in his class depending upon the available equipment, class size, physical facilities,

multiple copies of books, duplication machine, overhead projectar, etc.

(iii) The main problem that is considered in suggesting certain strategies is, "How could concepts on photosynthesis be *developed* in the minds of children in Class XI, using molecular, cellular, and ecological approach inherent in this Unit ?"

(iv) The previous knowledge essential for the child to learn advanced concepts in Class XI is of the following :

— Green plants are the primary producer of food.
— Green leaves, when tested for starch, do give a +ve result.
— CO_2, H_2O, light and chlorophyll are essential for leaves in a living plant to manufacture carbohydrates.
— O_2 is a by-product in the process of photosynthesis.
— Simple experiments related to the factors necessary for photosynthesis.

STRATEGY I

Concept to be Developed

Photosynthesis is a biochemical proeess involving CO_2, H_2O, chlorophyll, light energy, a reducing sustance and enzymes in a system.

Write the following equations as statements on the B.B. and use them for discussion :

(a) Water + light energy→No reaction
(b) Water + Chlorophyll + light energy+ NADP → O_2
(c) Water + CO_2 + Chlorophyll + light energy + NADP → O_2
(d) Water + CO_2 + Chloroplasts + light energy (off and on) + NADP → O_2 carbohydrates

Questions Useful for Discussion

— What is the role of chlorophyll as evidenced from No. (b) ?
— What happens in electrolysis ?
— Why NADP is used ?
— Can we consider the splitting of water with the help of light energy as photolysis ?
— What is the role of CO_2 in the process?
— How are chloroplasts different from chlorophyll as seen in the above (chloroplasts as living organelles, contains enzymes) ?

STRATEGY II

Concept to be Developed

Photolysis of water takes place during photosynthesis resulting in the by-product of O_2 evolved from water.

The teacher writes the reactants and end-products in the biochemical process as below :

$$CO_2 + H_2O \xrightarrow[\text{light energy}]{\text{Chlorophyll}} C_6H_{12}O_6 + O_2$$

Questions Useful for Discussion

— How many molecules of CO_2 are necessary to balance this equation ?
— How many molecules of H_2O are necessary to balance this equation ?
— Ask the children to balance the equation.

The teacher writes the balanced equation as follows :

$$6CO_2 + 6H_2O \xrightarrow[\text{light energy}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

The teacher asks the children to carefully study Strategy I (b) above and find out the source for O_2.

If O_2 is evolved from water, how can 6 molecules of O_2 be produced from 6 molecules of H_2O ? What should be done to the number of molecules of water ? The teacher mentions research studies to prove that the volume of

O_2 given out is equal to the volume of CO_2 taken in.

The teacher should discuss the labelling of Oxygen and demonstrate through B.B. work that O_2 is produced from water and *not* from CO_2.

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

Now, the teacher should ask the children to rewrite the equation in the light of the discussion.

$$6CO_2 + 12H_2O \xrightarrow[\text{light energy}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

STRATEGY III

Concept to be Developed

Chlorophyll acts as a light trapping device in the process of photosynthesis.

If white light (sun light) is passed through a prism, what are the different types of light seen ? What is the electromagnetic spectrum ?

The teacher draws on the B.B. a sketch depicting what happens to the visible spectrum when it is allowed to pass through chlorophyll suspension. What is the property of chlorophyll ? Which wavelengths of light are absorbed more by the chlorophyll ?

The teacher narrates the study on focussing a micro spectrum so that it falls parallel to a living spirogyra (a filamentous alga) in a slide with aerobic bacteria introduced into the system.

The teacher supplies the recorded data that aerobic bacteria were more active towards the two ends of the spectrum. The children are helped to analyse the data and interpret them in the light of the previous experimental study. The children may be helped to draw graphs with reference to chlorophyll absorbtion spectral studies with the help of the relevant data supplied by the teacher.

STRATEGY IV

Concept to be Developed

During photosynthesis, light energy is converted into chemical energy and is stored in the molecules of carbohydrates.

Let the children analyse the molecules of $C_6H_{12}O_6$ (the teacher may write the linear structural formula on the B.B.) and find out the bonds (chemical bond energy). If C, H and O from CO_2+H_2O ought to get themselves rearranged and synthesise a sugar molecule, what is necessary to bind the atoms ? What is the source of chemical energy present in the molecule of sugar ?

The teacher draws a pictorial representation of the solar energy reaching the leaf and the leaf in turn producing carbohydrates. What possibly happened to light energy in this process ? It would be better to help the children to recognise the uses of the chemical energy stored in the food. The children may also analyse the situation when wood burns (transformation of chemical energy into heat and light energies).

The other concepts to be developed in the Unit are the following :

(a) Light reaction, where in ATPs are harvested, constitutes cyclic and non-cyclic photo phosphorylation.

(b) Dark reaction, where in carbohydrates are synthesised, uses the chemical energy from ATPs generated in the light reaction.

(c) Chloroplasts are the sites for photosynthesis as they possess the enzymes and the necessary infrastructure for the biochemical process.

(d) Photosynthesis contributes to the formation of primary producers in food chains and webs in an ecosystem.

(e) Photosynthesis contributes towards interdependency in biotic associations in nature.

(f) Replenishing the O_2 in the atmosphere is mainly due to the process of photosynthesis.

(g) Photosynthesis, as a process, provides immense possibilities for tapping the enormous solar energy freely available for us on the earth, to solve the energy crisis that may arise in the future.

The teachers may plan for appropriate strategies when they attempt to develop the above-mentioned concepts. The writer of this article would be glad to be of any academic assistence to them.

Books for further reading

1. Hurd, De Hart, P. *New Directions in Secondary School Science,* Rand McNally, Chicago, 1970

2. Anderson, Roger, O., *Teaching Modern Ideas of Biology,* Teachers College Press, Colombia University, N.Y. 1972

3. Selmes, Cyril, *New moments in the study and Teaching of Biology,* Maurice Temple-Smith, London WC, 1974 □

The Case for Conserving Plants

STANIFORTH WEBB

At last we are beginning to appreciate just how much the plant world can give us, not only as food but by way of drugs and important raw materials that will grow scarce from other sources. But can we act quickly enough to save the species of plants we need?

TO NINE people out of ten the conservation of wild life means the conservation of animals, as the popularity of save the Seals compaigns has shown. Yet there is just as much need to conserve plants as animals and, in any case, the two are interdependent. Animals cannot survive without the food chains which always begin with plants, and wild animals cannot live a natural life divorced from their natural plant surroundings. We also need to conserve plants for the future of agriculture and of the world's pharmaceutical industries. It is paradoxical, but nevertheless true, that developments in science and technology are making us more and more dependent upon plants as natural resources, instead of less dependent as we might expect.

This was recently made clear by speakers at a conference of botanists and botanic garden directors at Kew, London, including the Director of the Cambridge Botanic Garden in England and the (English) Director of the Canary Islands Botanic Gardens. And, at the other end of the scale, developments now going on in English universities foreshadow the genetic engineering of plants to produce drugs, hormones and enzymes, and the development of plant single-cell cultures which will produce plant based products in reactor tanks like those used today to produce antibiotics and enzymes.

Untapped Potential

Nearly half of the medical prescriptions written every year contain some drug derived from plants as the main ingredient. Ninety per cent of the world's food comes from twenty plant species, and plant breeders are turning more and more to the wild to breed new strength into these domesticated varieties. But at present rates, the world will lose one-third of its arable land by the end of the century; nearly half the tropical rain forests have already been felled. The world's trees and plants are being destroyed faster and faster, at just the time when chemists and doctors as well as farmers and plant breeders are realizing the untapped potential of plant life, not only for human and animal food and as a source of medicinal durgs but, as the world's oil runs out, as a source of chemical feedstocks for industry.

Speakers at Kew from several countries were concerned that the demands of intensive agriculture, housing, road building, industry, forestry and tourism are causing plant species to disappear at an accelerating rate. And botanists have made a poor show compared with zoologists in educating the public to the need for conservation. One embittered botanist was heard to murmer that the smallpox virus stood a better chance of conservation than some of the beautiful and useful threatened plants on his list.

Yet plants and trees are about to become important as renewable sources of energy while hydrocarbons become scarce and expensive. Fast-maturing trees and high energy crops like sugarcane and cassava are excellent ways to trap and exploit solar energy. Newly-domesticated legumes can provide plenty of alternative to crops that need expensive nirtogenous fertilizers. Ethylene, essential to industrial chemistry, will by 1995 be derived from ethanol made by fermentation from carbohydrate crops.

Gene Reserves

But recognition of these future uses for plants and trees is taking place against a background of gene reserves shrinking with alarming speed, and this at a time when breeders of cereals and potatoes to name but two crops, have been turning to wild sources to find new genetic material to infuse into their breeding stocks, to enlarge gene pools and impart badly-wanted qualities of hardiness and resistance to disease. Usually only well-adapted local species of plants can be used to stabilize sand dunes or to rehabilitate industrial waste lands, but once the genes for such local adaptations have become extinct, then the adaptations have gone for good.

Tropical rain forests, teeming with plants and trees with medicinal properties and ultra-efficient photosynthetic systems, are being destroyed at an unprecedented rate. In South East Asia they contain at least 25,000 species flowering plants, many of which have an economic potential for crop diversification and improvement. In Malaysia alone, where rain forests cover about 13 million hectares, about 3,50,000 hectares are being cleared annually.

Botanic gardens are faced with the task of identifying which species are threatened, collecting them and building up stocks for eventual reintroduction into the wild, and they are needed for research into the breeding mechanisms of endangered species so that we can propagate them more effectively. They are needed as centres for research into the valuable properties of plants, including the identification of strains able to flourish on poor or polluted soils, species with medicinal properties and species with something to throw into the gene pool of one crop or another, in the way of hardiness or disease resistance. At present, above all, they are needed to educate the public, to arouse an interest in conservation and the need for it.

Dr. Conrad Gorinsky, who has set up a Biotechnical Research and Development Organization (Bo Tech) at St. Bartholomew's Hospital, is especially interested in conservation. He has already received help from the governments of Venezuela, Brazil and Guyana in his research, gathering traditional remedies from the oral cultures of the Latin-American Indians. He is now expanding his interests to other continents. Bo Tech's work has been largely responsible for the development of the Joboba plant (which produces an oil skin to sperm whale oil), of Leucaena, a nitrogen fixing legume which can survive extended droughts, and of the Guayele tree, which can produce natural rubber in semiarid conditions.

Dr. Gorinsky points out that nearly all the synthetic man-made drugs of today are copies of a relatively few active, naturally-occuring compounds, and that far more probably remain to be discovered than have so far been exploited. He also suggests that the best way of storing genetic resources is in the security of their own habitat, and that the best sources of ethnobotanical information about these habitats lies in the living cultures of primitive people who have solved the problems of pollution and avoided destruction of their natural habitat while still exploiting some, at least,

of its pharmaceutical potential.

Techniques such as those now being developed at Sheffield University's bio-chemistry department, for growing plants as separated single-cells under controlled conditions in huge tanks of nutrient fluid, are a far cry from the Amazonian and other forests. But the efficiency and low energy cost of plant-based systems, together with the advantage of being able to extract their products at a steady rate and under controlled conditions, makes it seem certain that such techniques will be used to obtain a range of drugs. Examples might be the steroids used in contraceptive pills, the heart stimulant digoxin and vegetable laxatives. It would be an appalling tragedy if, just when we are acquiring the first true appreciation of what the plant world can give us, that failure to appreciate and publicise the lack of conservation programmes should lead to irreparable losses of genetic diversity and a narrowing and diminishing of the whole splendid variety of the living world we should hold dear. □

Chemico Carrom Board

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PLAYING is a natural instinct of the child. While playing, children do not feel bored or burdened. Education gained unknowingly while playing will be more effective. Any game will have an extra stimulating effect. This informal method of education will also help use of leisure time more properly.

'Learning while Doing' is considered to be the best method of science teaching today. Subscribing to this method of teaching and learning science, I have developed some games for teaching science, with the slogan 'Learn while Playing.' These games are only one of the devices to make the subject more interesting, to supplement classroom teaching, to use leisure time effectively, to attract the truants to the class, and to educate the children according to their natural instincts. One of these games is the subject of this article.

The Chemico Carrom Board* is a game resembling the usual Carrom Board. In this game, dities have been painted different colours, with symbols of the elements written on them. Five sets of dities have been painted corresponding to five games. Details of the games are given below.

Game of Gases

Some properties of ten common gases are the focus point of this game. The molecules of all gases can be represented by 25 dities which correspond to their atoms.

From the marks given on the keyboard, the player will try to collect the atoms of any gas. The back side of the keyboard will be for counting the marks.

Game of Compounds

Here 12 dities stand for basic and 12 for acidic radicals. The Queen can be used for any radical. Each salt has ten marks. Looking at the names of the compounds on the keyboard, the player will try to collect the dities required for their formation. The correct symbols are given on back side of the keyboard.

Game of Elements

In this game, 12 dities represent metals and 12 non-metals, the Queen being a metalloid. Each metal has 3, non-metal 5 and the Queen 4 marks. There is no keyboard for this game.

Game of Valencies

The symbols and valencies of 24 elements have been written on two sides of the dities. The valencies are to be kept invisible during play. The Queen has zero valency. Each valency has 2 marks. No keyboard is required. One has to collect the dities of the same one colour.

Game of Configuration

This game is to be played while keeping in mind the configuration of the given 24 ele-

*This game was one of the exhibits at the National Science Exhibition for Children held at the Teen Murti Bhavan, New Delhi in November 1977.

ments. Each orbit has 1 mark. The elements having more than 4 orbits are to be given 4 bonus marks. The Queen has 6 marks. One can collect the dities of the same one colour.

The players, as usual, will collect as many dities as they can, keeping in mind the marks for the dities. One who obtains more marks will be the winner.

Thus, one can easily and playfully learn the following with the help of the Chemico Carrom Board :

1. Some properties of ten gases
2. Some formulas of some compounds
3. Chemical construction of some compounds
4. Which elements (12) are metals and which (12) non-metals
5. Valencies of 25 elements
6. Configuration of 24 elements

CHEMICO CARROM BOARD KEYBOARD

A *Game of Compounds*	B *Game of Configuration*		C *Game of Gases*	
Aluminium Sulphate	Li— 3	C— 6	Gases : H_2, N_2, O_2, NH_3,	
Sodium Carbonate	Be— 4	N— 7	SO_2, HCl, CO, CO_2, Cl_2, Br_2	
Sodium Chloride	B— 5	O— 8	1. Prepared over water	—2 Marks
Copper Sulphate	C— 6	F— 9	2. Acidic	—2 Marks
Ferrous Sulphate	Na—11	P—15	3. Basic	—7 Marks
		S—16	4. Combustible	—5 Marks
Sodium Bicarbonate	Mg—12	Cl—17	5. Suporter of Combution	—3 Marks
	Al—13	Ar—33	6. Lighter than air	—3 Marks
Silver Nitrate	Si—14	Se—34	7. Heavier than air	—2 Marks
		Br—35	8. Coloured	—5 Marks
Potassium Nitrate	K—19	Te—52	9. Action on slaked lime water	—7 Marks
		I—53	10. Characteristic smell	—2 Marks
Calcium Carbonate	Ca—20		11. Bleaching action	—3 Marks
	Rb—37			
Barrium Sulphate	Pt—78			

CHEMICO CARROM BOARD KEYBOARD

A'	B'	C'	
		Gases	*Properties*
$Al_2(SO_4)_3$	Li—2, 1	Te—2, 8, 18, 18, 6	H_2	1, 4, 6
Na_2CO_3	Be—2, 2	I—2, 8, 18, 18, 7	N_2	1, 6
NaCl	B —2, 3	C—2, 4	O_2	1, 5, 7
$CuSO_4$	C —2, 4	N—2, 5	NH_3	3, 6, 10
$FeSO_4$	Na—2, 8	O—2, 6	SO_2	2, 7, 10
$NaHCO_3$	Mg—2, 8, 2	F—2, 7	HCl	2, 7, 10, 11
$AgNO_3$	Al—2, 8, 3	P—2, 8, 5	CO	1, 4
KNO_3	Si—2, 8, 4	S—2, 8, 6	CO_2	2, 7, 9
$CaCO_3$	K—2, 8, 8, 1	Cl—2, 8, 7	Cl_2	2, 5, 7, 8, 10, 11
$BaSO_4$	Ca—2, 8, 8, 2	Ar—2, 8, 18, 5	Br_2	2, 5, 7, 8, 10, 11
	Rb—2, 8, 18, 8, 1	Se—2, 8, 18, 6		
	Pt—2, 8, 18, 32, 17, 1	Br—2, 8, 18, 7		

NOTE : A, B, C are the front sides of the Keyboards and A', B', C' are their reverse sides.

Radioactive Isotopes as Indicators

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ISOTOPES are the atoms of some elements having the same atomic number but different atomic masses. The chemical and physical properties of the isotopes of an element may be regarded as identical especially if the atomic masses are not too low. Since redioactive isotopes (or radio-isotopes) can be detected easily, they are used as 'Indicators' or 'Tracers' in chemical, biological and industrial studies.

If a stable metal and a trace of its radioactive isotope are mixed together and converted into a compound under study, then, as a consequence of the virtual identity in physical and chemical properties of their compounds, the two isotopes will always remain in the same proportions, irrespective of the physical state or chemical behaviour of the element. The active isotope should be such that it does not decay too rapidly because its concentration is estimated from its activity.

The solubilities of some sparingly soluble salts can be determined by using radio-isotopes. If the solubilities of sparingly soluble salts, e.g., lead sulphate or lead chromate are to be determined, then a very small amount of radium-D compound, whose X-Ray activity has been pre-determined by an electroscope or any other similar device, is mixed with a weighed quantity of the inactive lead compound so that there is a known relationship between the radio-activity and the lead content of the system. The mixture is then converted into the sparingly soluble salt, e.g., sulphate or chromate and then its saturated solution in water is prepared.

A known volume of this solution is removed and evaporated to dryness and the activity of the residue is determined by means of an electroscope or a Geiger counter. The activity is proportional to the amount of the salts present. To start with, the activity associated with a given mass of the salt is known which is then used for determining the unknown mass of the substance.

In organic chemistry, this technique is used to know the exact mechanism of some reactions, for example, the isomeric change of n-chloroacetanilide to p-chloroacetanilide in the presence of hydrochloric acid. This change may occur by any of the following two mechanisms. The first is an intramolecular mechanism in which the chlorine of hydrochloric acid is not involved; and the second mechanism may be one in which the chlorine is formed as an intermediate. When a sample of hydrochloric acid, containing radioactive chlorine is used, it is found, that p-chloroacetanilide obtained is radioactive. This indicate that chlorine atoms from hydrochloric acid are substituted in the ring and show that the reaction takes place through the second mechanism.

The use of tracers is of great importance in studying the processes that occur in living organisms. It is common for a normally functioning organism to take in those chemical elements which constitute a substantial part of the organism, e.g. oxygen, hydrogen, nitrogen, iron, etc. Naturally, a chemical analysis, which, as it stands, is a big problem when dealing with living bodies, does not permit any distinction between the atoms introduced into the

organism and those originally present in it. Tracer atoms are somewhat different. They are easily detected even when the related chemical elements are already present in the organism.

The use of the tracers has made it possible to determine the rate at which different substances move to various parts of the body and to find out in which part of the body a given substance accumulates. It is observed, for example, that on entering the organism iodine concentrates mainly in the thyroid gland. This makes it possible to use radioactive iodine (I_{-131}) to detect certain forms of diseases of thyroid glands, e.g., goitre, etc.

Radioactive tracers have become invaluable to surgeons now-a-days. Before operating for tumours of the brain, it is particularly important to know the exact site of the tumour. This is found out by using a redioactive iodine compound, diodofluoresceing, which is absorbed by the tissue of the tumour. This compound, tagged with radioactive iodine and injected into the organism, concentrates in the tumour and emits gamma rays, thus clearly indicating the site of the tumour.

Radioactive tracers are playing a big role in agriculture. They are being used to find the effective ways of raising crop yields. The tracer is mixed with different fertilizers which are absorbed by the plants along with the soluble salts of fertilizers and can be detected in any part of the plant by a Geiger counter. These experiments also help in finding out the growth of a plant, the time when they are required, the places where they are required and the amount that should be introduced. It is found, for instance, that maize assimilates phosphorous fertilizers during the early period of vegetation. At the later stages, its deeply germinating roots extract straight from the unfertilized soil the bulk of the phosphorous that it needs. In contrast to maize, potatoes get a constant supply of phosphorus from fertilizers. Experiments performed with tobacco plants are not very effective.

The tracer techniques simplify the problems of finding the durability of the hard-working machine parts. The rubbing surfaces are made radioactive by adding radioactive substances to the alloy out of which the parts under study are cast or by pressing radioactive materials into them. During friction, minute particles of metal are torn away from the rubbing surfaces and get into the lubricant. By putting a Geiger counter in the tank, it is possible to register the appearance in the lubricating oil of any traces of radioactivity and to get an idea of the extent of wear and tear of the rubbing surfaces long before any visible signs of wear and tear are apparent.

These are some of the various uses to which the radioactive isotopes are being put now-a-days. Extensive researches are being carried out and numerous other advantages of isotopes are coming to light. The day is not far away when radioactive isotopes will become a part of our technical, commercial and daily life. □

Crossword Puzzle

JYOTIRMOY HUI

THE PRESENT crossword puzzle is designed to fit some names, the names of scientists who investigated a particular disease, its bacillus or syndrome or any medical test or any other medical device. Their names have been immortalized by naming the particular disease, bacillus, syndrome, test, operation, etc., after their names.

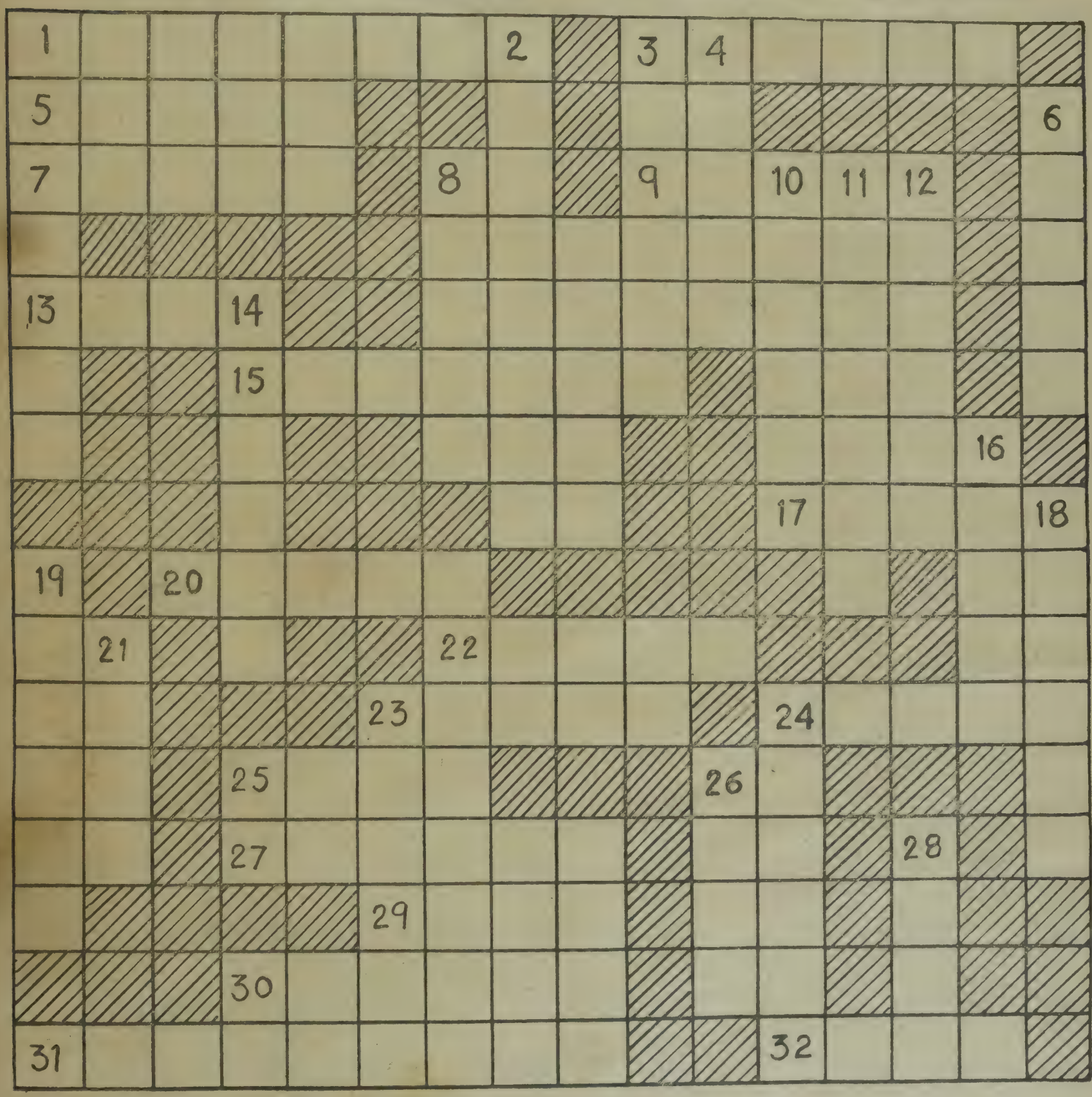
CLUES

Across

1. The English physician whose name has been immortalized with Angina Pectoris (severe but temporary attack of cardiac pain resulting from myocardial ischaemia).
3. An operation dividing the muscle coat at the junction between the oesophagus and the stomach, performed to relieve the difficulty in swallowing in cases of cardiospasm, has been named after this surgeon of St. Georg Hospital, Leipzig.
5. Small painful areas occuring in the finger pulp of a patient with subacute bacterial endocarditis have been named after this English physician.
7. A complication of floating kidney (nephroptosis) is popularly named after its investigator, a Polish physician.
9. Pyorrhoea alveolaris (flowing of pus from teeth sockets) has been named after this American dentist.
13. Tuberculosis is named after this German bacteriologist.
15. The complication of deficient secretion of aldosterone and cortisol from the adrenal cortex is popularly known after its investigator, an English physician.
17. Arthritis deformans juvenilis (a form of rheumatoid polyarthritis occurring in infants and children) has been named after its investigator, an English physician.
20. The syndrome of chronic arthritis associated with leucopenia (decreased number of leucocytes in blood) and splenomegaly (enlargement of the spleen) has been named after this American physician.
22. Hypertrophic biliary cyrrhosis is popularly named after its investigator, a French physician.
23. A test for typhoid fever is named after this French physician who worked on bacterial agglutination and its application to the diagnosis of typhoid fever.
24. Cancerous eczema of the nipple is popularly known after its investigator, an English surgeon.
25. The syndrome of benign ovarian tumour is named after this American surgeon.
27. The technique of using fascial strips from the thigh for radical cure after

reduction of a hernia is named after this Canadian surgeon.

29. The amputation just above the ankle joint that provides an endbearing stump, especially useful in primitive conditions where elaborate artificial limbs are not available, is named after this Scottish surgeon.
30. The corneal rodent ulcer is named after this German ophthalmologist.
31. The syndrome of mask-like expression, shuffling gait, tremor of the limbs and pill-rolling movements of the fingers is named after this English physician.



32. Dacrycystorhinostomy, an operation to establish drainage from the lacrimal sac (situated above the upper, outer canthus of the eye) into the nose when there is obstruction of the naso-lacrymal duct is named after this Italian ophthalmologist.

Down

1. Lymphadenoma (progressive disease of reticulo-endothelial system shown in generalized enlargement of lymphatic glands and splenomegaly) has been closely associated with the name of this English physician.
2. Slight pressure on skin causes slipping of apparently normal epidermis in the way a rubber glove moves on a wet hand. This process is named after this Russian dermatologist.
3. Severe headache due to the release of histamine (a naturally occurring chemical substance in body tissues) has been named after its investigator, an American physician.
4. Sarcoma involving shaft of long bone before the twentieth year has been known after this American pathologist.
6. Erythema induratum (a chronic, recurrent disorder, involving the skin of the legs of women) has been popularly known after this French dermatologist.
8. Living attenuated polio virus which, when given orally, produces active immunity against poliomyelitis has been named after this American bacteriologist.
10. Thyrotoxicosis (a condition due to excessive production of the thyroid gland hormone, thyroxine) has been widely known after this Irish physician.
11. The name of this German pathologist has been immortalized with hypernephroma (a malignant neoplasm of the kidney).
12. The vaccine for poliomyelitis (injection) has been named after this American bacteriologist.
14. The disease leprosy is popularly known after this Norwegian physician who gave, for the first time, a proper clinical description of mycobacterium leprae causing the disease.
16. The operation for spinal fixation has been named after this American surgeon.
18. Deplegia (symmetrical paralysis of legs) of spastic type is closely associated with the name of this English surgeon.
19. The name of this English clinician has been immortalized with nephritis (inflammation of the kidney).
21. The syndrome of ascites, hepatic enlargement and pleural effusion occurring in constructive pericarditis has been named after this Czechoslovakian physician.
23. Liver cyrrhosis due to the inborn error of copper metabolism has been closely associated with this English dermatologist.
24. Bossing of the frontal bones in congenital syphilis has been named after this French physician.
26. Acute delirious mania (a severe psychosis) is named after this Scottish anatomist.
28. Spinal affections like spondylitis, spinal caries, spinal tuberculosis are named after this English surgeon.

Solution

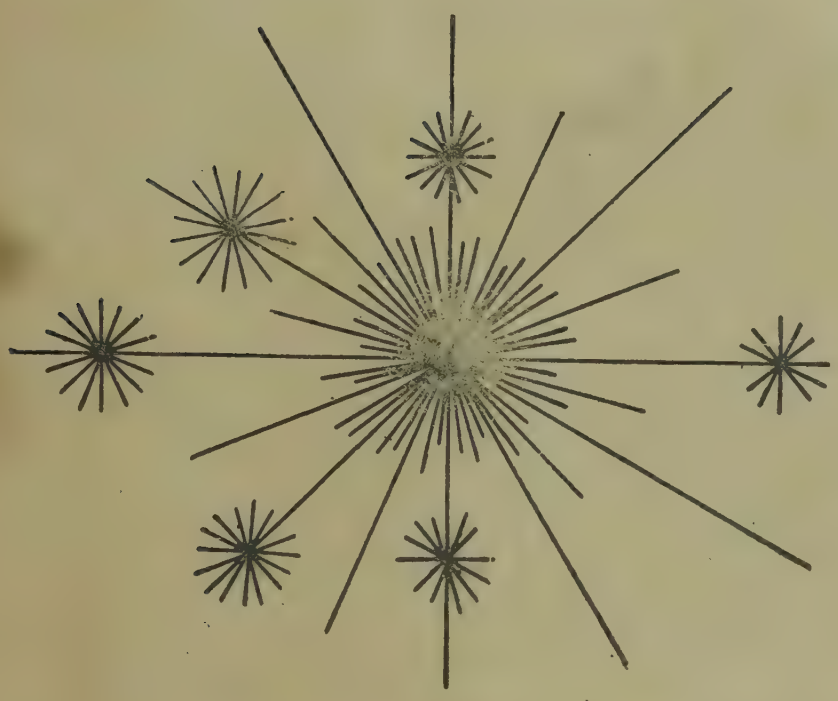
Across		
1. William Heberden (1710-1801)	English physician	Heberden's disease
3. Ernst Heller (1877-1964)	German surgeon	Heller's Operation
5. William Osler (1849-1919)	English physician	Osler's nodes
7. Jozef Dietl (1804-1878)	Polish physician	Dietl's crisis
9. John Mankey Riggs (1810-1885)	American dentist	Rigg's disease
13. Robert Koch (1843-1910)	German bacteriologist	Koch's infection
15. Thomas Addison (1793-1860)	English physician	Addison's disease
17. George Frederic Still (1888-1941)	English physician	Still's disease
20. Augustus Roi Felti (1895- —)	American physician	Felty's syndrome
22. Victor Charles Hanot (1844-1896)	French physician	Hanot's disease
23. Fernand Widal (1862-1929)	French physician	Widal test
24. James Paget (1814-1899)	English surgeon	Paget's disease
25. Joe V. Meig (1892- —)	American surgeon	Meig's syndrome
27. William Edward Gallie (1882-1959)	Canadian surgeon	Gallie's operation
29. James Syme (1799-1870)	Scottish surgeon	Syme's amputation
30. Albert Mooren (1828-1899)	German ophthalmologist	Mooren's ulcer
31. James Parkinson (1755-1824)	English surgeon	Parkinsonism
32. Addeo Toti (1861-1946)	Italian ophthalmologist	Toti's operation
Down		
1. Thomas Hodgkin (1798-1866)	English physician	Hodgkin's disease
2. Pyotr V. Nikolsky (1858-1940)	Russian dermatologist	Nikolsky's sign
3. Bayard Taylor Horton (1895- —)	American physician	Horton's syndrome
4. James Ewing (1866-1943)	American pathologist	Ewing's tumour
6. Antonie Pierre Ernest Bazin (1807-1878)	French dermatologist	Bazin's disease
8. Albert Bruce Sabin (1906- —)	American bacteriologist	Sabin vaccine
10. Robert James Graves (1797-1853)	Irish physician	Grave's disease
11. Paul Alfert Grawitz (1850-1932)	German pathologist	Grawitz tumour
12. Jonas Edward Salk (1914- —)	American bacteriologist	Salk vaccine
14. Armauer Gerhard Henrik Hansen (1841-1912)	Norwegian physician	Hansen's disease
16. Fred Houdlett Albee (1876-1945)	American surgeon	Albee's operation
18. Willian John Little (1810-1894)	Englisn surgeon	Little's disease
19. Richard Bright (1789-1858)	English clinician	Bright's disease
21. Arnold Pick (1851-1924)	Czechoslovakian physician	Pick's disease
23. Sir J.E. Wilson (1809-1884)	English dermatologist	Wilson's disease
24. Joseph Parrot (1829-1883)	French physician	Parrot's nodes
26. Sir Charles Bell (1774-1842)	Scottisn anatomist	Bell's mania
28. Percivall Pott (1714-1788)	English surgeon	Pott's disease

ANSWER

H	E	B	E	R	D	E	N		H	E	L	L	E	R	
O	S	L	E	R			I		O	W					B
D	I	E	T	L		S	K		R	I	G	G	S		A
G						A	O	C	T	N	R	R	A		Z
K	O	C	H			B	L	R	O	G	A	A	L		I
I			A			I	S	O	N		V	W	K		N
N			N			N	K	H			E	I		A	
			S				Y	N			S	T	I	L	L
B		F	E	L	T	Y						Z		B	I
R	P		N			H	A	N	O	T				E	T
I	I				W	I	D	A	L		P	A	G	E	T
G	C		M	E	I	G				B	A				L
H	K		G	A	L	L	I	E		E	R		P		E
T					S	Y	M	E		L	R		O		
			M	O	O	R	E	N		L	O		T		
P	A	R	K	I	N	S	O	N			T	O	T	I	

N. N. HIGH SCHOOL (MAIN)
BANGALORE-42

Science News



Voyager-1 Completes Investigation of Jupiter

Voyager-1 is now heading for a rendezvous with Saturn next year following the most comprehensive close-up exploration ever undertaken of the gigantic planet Jupiter. The 830 kilogram American spacecraft collected more detailed information on Jupiter and its inner moons than had been gained in the centuries since Galileo first discovered those moons in 1610, reports James Fuller in a USICA press release.

The robot spacecraft sped within 278,400 kilometres of the multicoloured clouds of Jupiter on March 5, and its television cameras sent back discovery after discovery to the Jet Propulsion Laboratory in Pasedena, California: the aurora circling Jupiter, the existence of a large, young volcanic mountain on the moon Io, the vivid coloured surfaces of all four Galilean moons, and the discovery that radiation bombardment has filled hundreds of metres of Io's surface into space.

Voyager-1, which started its journey 18 months ago at Cape Canaveral, Florida, is a large drum-shaped craft dominated by a 3.6 metre wide dish antenna and several other antennas and booms carrying scientific instruments and two slow-scan television cameras. For nearly two months of its journey Voyager studied the puzzling radio emissions from Jupiter and returned increasingly spectacular photographs of the planet's multicoloured bands of upper-atmosphere clouds.

As Voyager approached Jupiter, at a rate of more than 960,000 kilometres a day, its cameras shot a sequence of pictures of the mysterious treat red spot, a huge, persistent feature that was first observed by the English scientist Robert Hooe in 1669. Nowhere on the planet are the atmospheric currents as complicated as they are around the red spot. Voyager photos revealed at least five huge swirls of gas circling counter-clockwise at speeds of 320 to 400 kilometres an hour over a region three times the size of the Earth, creating what still is apparently the largest and most permanent hurricane in the solar system.

As Voyager flew within 19,200 kilometres of Io, Jupiter's innermost major satellite, it returned a sequence of high-resolution pictures that produced one of the biggest scientific surprises of the mission. The photos revealed the existence of a large, young volcanic mountain on Io, indicating to project scientist that the Jovian moon, like the Earth, is still an active body with a molten interior.

OVER THE CLOUDS—The moon Io appears suspended over the Jovian surface in this view from about 8.3 million kilometres

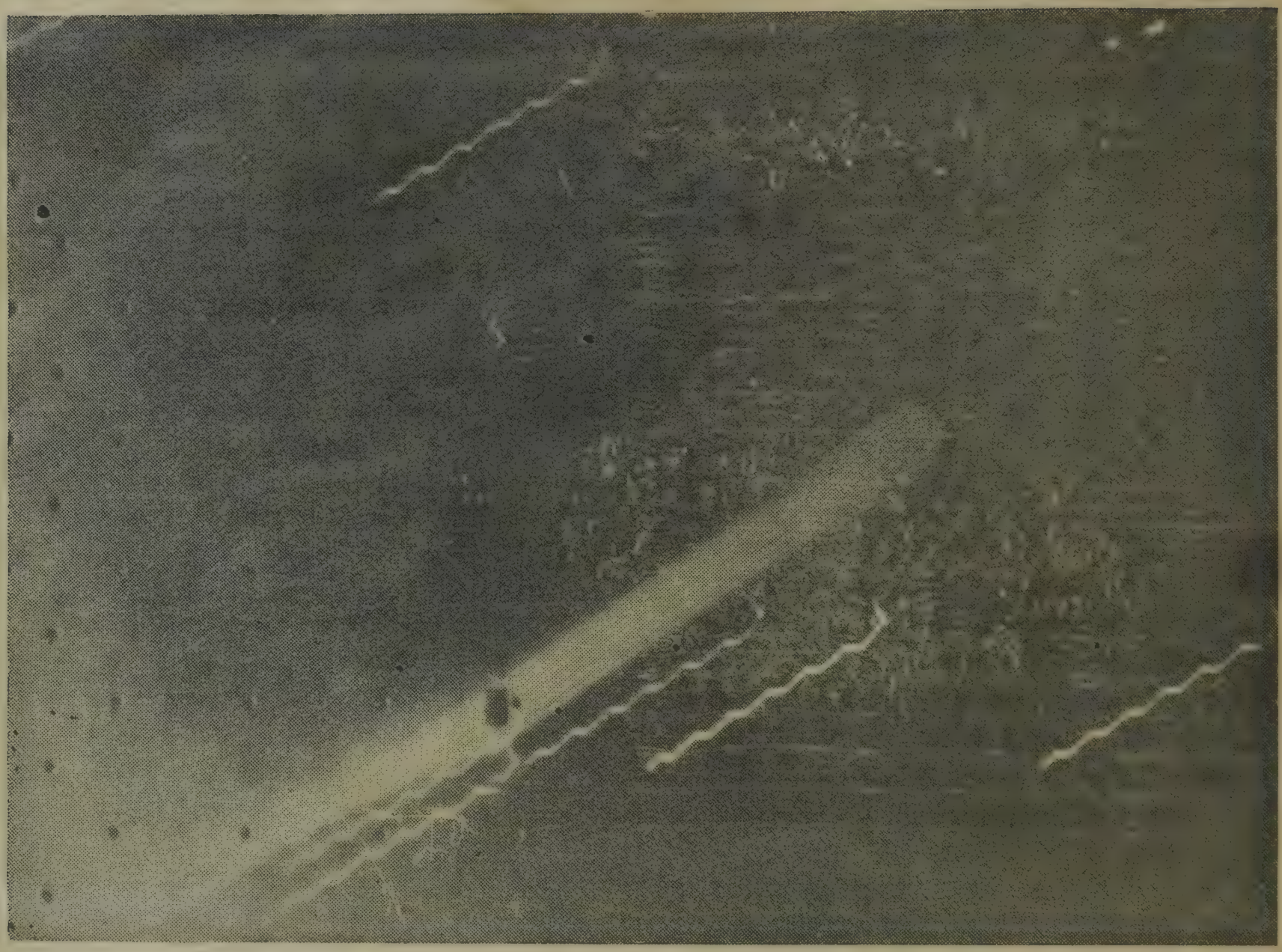
Dr. Laurence Soderblom, of the U.S. Geological Survey, said the volcano rises a mile (1.6 kilometre) above its surrounding terrain, has an irregularly shaped, 48 kilometres wide crater and dark lava flows extending out more than 96 kilometres. Not a single meteorite-impact crater is visible on the slopes or out along the lava flows, strong evidence that the feature is relatively young.

Io's yellow, white and deep red surface possesses almost every imaginable geological feature—plateaus, scraps, channels, rifts, and mesas. Project scientists said it was unlike any other "world" they had seen in the solar system.

"The important thing we are beginning to see," said Harold Maursky, also of the Geological Survey, "is that Io may be the Earth of the Jovian system. Its surface is by far the youngest we have seen among the rocky bodies of the solar system, other than the Earth. Ganymede looks more like Mars. Callisto looks ancient and cratered like Mercury. But Io may be younger and even more dynamic than the Earth."

The Voyager mission has led to a number of other surprises, such as discovery of Jupiter's ring. Now planetary physicists must explain how such rings can form and persist. With three planets—Jupiter, Saturn, and

UNSUSPECTED RING—One of the major discoveries of the Voyager-1 mission was the first evidence af a ring around Jupiter. It appears as a broad light band in this view (top) from a distance of 1.2 million kilometres.



Background stars trace wavy pattern because of spacecraft motion during the 11-minute-plus exposure time. The ring is believed to be about 30 kilometres thick and to circle about 57,000 kilometres above the visible cloud deck.

Uranus—now known to have ring systems, these rings must be considered a typical planetary feature, not just a freakish phenomenon.

Meanwhile, Jupiter's colourful, turbulent surface challenges scientists studying fluid dynamics to figure out what is going on. Voyager's cameras showed dozens of cyclones and hurricanes measuring 960 kilometres across scattered over the face of the planet. One thing showing up is the puzzling phenomenon of huge cyclones overtaking and attaching themselves to other giant cyclones at the tops of the clouds. Some cyclones speeding across the planet at almost 320 kilometres an hour "stick" to other cyclones for as long as 12 days, then break apart again. Scientists believe that studying the planet's atmospheric processes will lead to a better understanding of the Earth's weather.

As Voyager scientists analyse their data over the next several months, they will refine their early impressions and begin to answer some of the questions these have raised. At the same time, they will choose those aspects of the Voyager-1 data that highlight phenomena they want to look at again when Voyager-2 flies by Jupiter in July.

No Danger from Nuclear Device Lost on Nanda Devi

A committee of scientists set up by the Government of India to study and assess the problem created by the nuclear device lost on Nanda Devi has unanimously expressed the view that the hazards of radiation because of release of plutonium from the device to the public at large are "negligibly small in magnitude and should not be a matter for alarm", says Government of India press release.

The committee drew its conclusions after studying the relevant material available, holding discussions with the persons concerned with the project and with the specialists in the field relevant to the problem and taking into consideration the results of analysis of samples carried out from 1966 to 1970 and in early 1978.

The committee considered several possibilities. These were that the device could have fallen on the south-west face of the mountain ; that though damaged outwardly as a result of the fall from where it was left, it could still be intact ; that it could have been burried in the glaciers or in the debris on the slopes of the mountain or that it could have fallen into the mountain streams and finally reached the gorge of Rishi Ganga ; or that as a result of multiple impacts during the fall the device might have been very badly damaged/disassembled and thus scattered all over, in which case the radioactive material would have got released into the environment.

The committee came to the conclusion that none of the credible accident conditions could lead to airborne contamination due to plutonium. It also considered the incredible situation of the capsule(s) being expelled by hard impact and causing contamination of the air. The probability of such an accident was as low as three in 10 million, and risk to the population even then would be as low as one in 2000.

The committee, therefore, concluded that after detailed analysis of hypothetical accident conditions that Pu-238 source lost near Nanda Devi hills is not likely to present any radiation hazard, and the future hazard potential ever/ any, due to radioactivity in the water route, would be such as to involve concentrations which are one thousand times less than the permissible concentrations.

The committee recommended a continuing programme of monitoring the environment to watch for any significant radioactive contamination. This monitoring should be of all elements—air, waters, local flora and fauna, soil and cross-sectional samples of sediments in the water beds.

The committee pointed out that in the case of device being still intact and living buried somewhere there was no hazard unless the device was disturbed or disintegrated. It was desirable that the peolpe living in the region should be informed that if someone came across or saw an object corresponding to the description of the device, he should not tamper with it but should immediately inform the local authorities. The committee observed that recovery of the device was the most obvious way of setting at rest all apprehensions and countinued thought should be given to it.

The nuclear device was lost on Nanda Devi in Octoder 1965 where it was to be installed as part of the monitoring equipment by an expedition consisting of Americans and Indians. The climbers had to retreat from about 609 metres below the Peak, because of extremely bad weather conditions. They left behind one box containing electronic equipment and accessories and a nuclear power generator on a carrying frame. Efforts to recover the equipment in 1966 and 1967 proved futile. Surveys and tests, however, did

not indicate either enhanced infrared neutron or alpha radiation anywhere in the areas. Tests of the samples collected from the nullahs and glaciers and waters of Rishi Ganga showed negative results. Tests of the samples of silt and water collected in April 1978 from the upper Ganga also showed that there was no radioactive contamination of the water and soil.

Oceanographic Research Vessel

India will soon have an Oceanographic Research Vessel (ORV) for research and development of non-living resources. The ORV will collect vital data relating to the Indian Ocean area which is not available to Indian scientific Institutions. It will among other things, undertake geoscientific research on the continental shelf and the slope of the Indian subcontinent and in deep sea of the Indian ocean; meteorological research for study of the weather; and biological, physical and chemical oceanographic research.

Oceanographic research has great significance for India with its long coastline and the Indian ocean region being comparatively less explored. Recognising the importance of oceanic water and sea bed as vast storehouse of both living and non-living resources, the Government of India enacted the Maritime Zones Act, 1976 reserving the right of Survey and exploitation of marine resources of the Exclusive Economic Zone and the Continental Shelf exclusively for the Indian people. It also enables us to exercise full control over the conduct of oceanographic research, immigration, pollution and anti-smuggling activities. It brings upon us the urgent responsibility for protection of offshore installations and marine activities and creation of the requisite infrastructure for oceanographic research and surveys of marine resources. To ensure optimum utilization of research facilities and proper coordination the Ocean Science and Technology Agency (OSTA) was set up in 1978.

The total cost of the acquisition and operation of the vessel over a period of five years has been estimated at Rs. 28.49 crore. Of this, Rs. 20 crore, covering the cost of the ship and equipment, will be provided by the Federal Republic of Germany as capital aid and grant.

The construction and commissioning of the ORV will take approximately three years.

A standing committee has been set up under the OSTA to draw up five-yearly and annual research programmes to monitor their progress. While actual research will be undertaken by the various user agencies, the OSTA will plan and coordinate day-to-day execution of the project.

It is envisaged that the ORV may also be used for collaborative programmes with other countries for resource-oriented research in our economic zone for placer deposites and hydrocarbons and in the Indian Ocean for polymetallic nodules. PIB

Tidal Power Through 'Caterpillar'

An engineer from Aurangabad claims that he has devised a process to generate electricity from both low and high sea tides.

Shri G.P. Waiker, works manager of an industrial concern, told reporters that the process invented in 1973 would be far cheaper both in installation and generation costs than hydel and thermal power.

The installation cost would be around Rs. 2.5 crore to produce 5 MW sufficient to meet the domestic power requirement of a population of 400,000. The generating cost would not exceed five paise per unit.

He was willing to demonstrate his method through a prototype working model. He explained that it was a "caterpillar-type plant with conveyor system," requiring no import of technology.

Hundreds of such small and big "caterpillar" plants could be installed along the underdeveloped coastal areas of the country. The 1,000 km Maharashtra coast alone could take 150 such plants.

Shri Waiker said that his method was somewhat similar to the methods adopted in Swedon and Norway. But whereas these countries harnessed only high tides at a particular time of the year, his method would utilize low tides for the whole year.

Haldi-Based Drug for Rheumatism

The Central Drug Research Institute has developed a safe and non-toxic compound from *curcuma longa* (*haldi*) for treatment of patients of rheumatism.

The Institute's director, Dr. Nitya Anand, said in an interview that during the trials, the new c mpound had been found to have no effect on the blood pressure and that it had lesser chances of producing stomach ulcer as compared to equal doses of the commonly used drugs phenyl butazone and cortisone.

Dr. Anand said that the new compound had so far given encouraging results during its use at the Post-Graduate Medical Institute at Chandigarh and other hospitals.

Energy from Solar Water Heaters

In its exploration to find ways of utilizing alternate sources of energy, the Indian Copper Information Centre at Calicut has developed two units of copper-panelled solar water heaters.

Presiding over a symposium on copper in electrical industry organized by the Centre, Dr. D.P. Antia, President, ICIC, said the development of solar water heaters was only a part of the solution to the ever increasing need for energy. The conventional forms, both thermal and electrical, needed to be developed simultaneously to improve the performance efficiency.

Since copper and its alloy still constituted the best material for electrical applications, the Centre had taken up research and development programme to develop new alloys which combined additional advantages of higher strength and better performance high temperature.

According to Dr. Antia, India would soon enter the era of super thermal power projects. However, there was "a crying need" to improve the operational efficiency of the existing thermal stations and to reduce transmission losses.

Galaxy with Double Nuclei Discovered

An unusual galaxy with a double nuclei has, for the first time, been discovered by the radio astronomers of Sweden, West Germany, the USA and the Soviet Union. Its existence was only predicted by theoreticians.

The discovery may increase scientists' knowledge of the phenomena of "black holes" in outer space.

The experiment was conducted with a global system of radio telescopes, one from the Soviet Union's Crimean Astrophysical Observatory, one from West Germany's Max Planck Institute, three American and one Swedish instrument.

Electric Power from Human Waste

Every person in India produces waste equivalent to 10 litres sludge gas that can generate 5 kw of electrical energy.

Electricity from human waste is to be produced by scientists of the National Aeronautical Laboratory at Bangalore.

The plan is to collect sludge gas from Bangalore's sewage treatment plant and use it to run aero-engines to produce electricity.

A NAL study on the economies of power from sludge gas shows that the capital cost would be about half that of a diesel generator installation. The running cost would depend on the price of sludge gas.

Based on this estimate, NAL says, Delhi can have a 7.5 MW power plant operating on sludge gas. There is enough sewage gas to set up a 3.2 MW power plant at Bangalore.

Aerogas turbines of the turboprop variety could be modified to generate electricity using sewage gas. Several turboprop engines such as Rolls-Royce, Dart and Russian AI-2Os are now operational in India, and many of them are available after their life in aircraft has expired.

Electricity from sludge gas will soon be demonstrated by the propulsion division of NAL using a "time-expired" Dart-514 aero-engine.

The aero-engine would use sludge gas produced at the K and C Valley sewage treatment plant 1 km away from NAL. The plant produces 9.900 cubic metres of sludge gas a day.

Using this gas, NAL plans to produce 3,500 kw of electricity a day with the help of the aero-engine.

If the pilot project is a success, it would be possible to set up power plants based on sewage waste in big cities all over India where sludge gas at present is wasted.

Bacterial Compass

Scientists have found that some bacteria synthesize iron compasses within themselves that orient them to the earth's magnetic field.

The National Science Foundation, which announced the discovery, said the find could have major implications in research on the homing mechanisms of animals and other organisms.

Hope for Cancer Patients

A beam of bright light has reduced and in some cases destroyed tumours which have been treated by a light-sensitive chemical, according to Dr. Thomus Dougherty, principal cancer research scientist at Rosewell Park Memorial Institute in Buffalo.

The treatment had been used successfully on tumours just under the skin of about 50 patients, Dr. Dougherty said, and he is working on a technique that would allow doctors to apply light treatments to tumours burried deep in the body.

According to another line of research, scientists came a step closer to developing a vaccine against cancer.

A vaccine that is nearly 100 per cent effective against all forms of cancer in rats and mice has been developed by scientists at the National Cancer Institute in Bethesda, Maryland, Dr. Robert Huebner announced.

Dr. Huebner, 65, who headed the research project, said the vaccine was "species-specific" meaning the mouse vaccine works only in mice and the rat vaccine only in rats. However, the scientific principles that led to the development of these vaccines might make it possible to develop a similar vaccine for humans.

The vaccine which operated on the same basis as those for such diseases as polio and measles.

The organism which the caused illness is injected in a tiny quantity or a weakened condition into patients, whose bodies respond by producing natural defences against the invasion.

The next time the body is exposed it has an army of defences waiting.

Dr. Huebner said cancer-causing agents, including some chemicals and viruses, produced genetic changes that transformed normal cells into cancer cells.

The damaged portion of the gene which caused cancer cells to multiply out of control, could be removed from cancer cells by using certain kinds of viruses, he added.

Project for Waste Heat

Industrial use accounts for a high percentage of primary energy consumption. Much of this energy is eventually dissipated as waste heat. One method of reducing losses of energy is to convert this waste heat into electricity to augment the plant supply, and so reduce overall costs.

This method of energy recovery is the subject of a research project involving Dr. D.O. Kelly (Bradford University), Mr. G. Musgrove and Professor J. Sherlock (Brunel University), Dr. I.K. Smith (City University) and Mr. S.S. Wilson (Oxford University) for which the Science Research Council has awarded a grant of £ 27,050 over the next two years.

The project forms the first stage of a programme which might lead to the development of a deviced aimed at the conversion of waste heat into electricity by means of a high speed turbine generator combination. The turbine would use a heavy organic vapour as the working medium enabling relatively low waste heat temperatures to be employed and would be coupled directly to a generator, to avoid the need for gearing. The turbine speed could vary during load changes, generator output being converted to synchronous mains frequency by solid-state techniques.

The grant holders claim that adoption of the developed device would represent an important advance in energy-saving practice.

Catalysts Developed for Obtaining Petrol from Coal

Process technology for the conversion of coal into liquid and gaseous fuels may be significantly changed and improved as a result of using new types of catalysts developed by a chemist of the Weizmann Institute of Science, Rehovot. Dr. Joseph Shabtai is the inventor.

Announcing this, the Institute spokesman said that Dr. Shabtai had developed catalysts which could be useful in the initial stages of coal liquefaction, as well as in the later stages of upgrading the raw coal liquids into conventional fuels, petrol, kerosene, fuel oils, etc.

Research began several years ago at the Institute and continued during Dr. Shabtai's sabbatical as a visiting professor at the University of Utah which has large local deposits of coal tar, sand and oil shale. BIS □

Book Review

A New Physics

D. Bryant and D.G. Kershaw, Hodder and Stoughton, London, 1978, pp. 472, £.3.60

THE teaching of science, particularly physics, contributes to the development of awareness of the physical laws and principles and understanding of how these laws operate in our environment and affect our daily life. In physics, the students learn to derive the important concepts, fundamental laws and relations by rigorous means to reach a logical conclusion drawn from the observations made during experimental work. An examination of the method of inquiry peculiar to physics reveals that the basic ingredients of this method are experimental work, empirical experiences and abstract mental processes. It is the combination of these processes which makes physics find a place in school curriculum since these are regarded as the fundamental processes for training the mind.

In physics it is not just the question of communicating facts or subject matter that really matters, it is the methodology which allows the students to penetrate into the spirit of science and into the structure of our scientific and technical age. It is the experimental experience and its mental digestion which leads to the appreciation of the thrill of exploration.

This aspect of physics has been very well recognized throughout the book *A New Physics*.

The scope of the content of the book 0-level physics has been spelt out in the preface. The book follows a very traditional approach in its organization in which one takes off from mechanics and after making suitable stop-overs at heat, electricity and magnetism and travelling through atomic and nuclear physics, one finally lands up at oscillations and optics.

In the chapter on Aims of Physics, the authors have stressed the importance of measurements in physics but little effort has been made in the body of the text to develop the concepts underlying measurements and significant figures. In a book which has attached high value to experimental work in physics, this omission may look quite serious. Further, in the chapter on Motor Effect the authors have contributed an article on Hall Effect which has not been made use of at all in the later part of the chapter. The relevance of Hall Effect in the chapter of Motor Effect is not very clear. Moreover, Hall Effect is not applicable in the construction and functioning of A.C. and D.C. motors and galvanometer which constitute the main body of this chapter.

The reason for having introduction in the begining of some, and not all, chapters is also not clear. An introduction to a chapter is generally considered a good feature of a book since, besides motivating a reader, it prepares the groundwork for developing the chapter.

The influence that physics exerts on the life of an individual and the community through the application of its results is also within the purview of physics education. The authors have recognized this aspect of physics and have included a large number of photographs of the objects where a particular law or principle of physics is made use of. These photographs also present a functional aspect of physics to young readers. Another interesting feature of the book is the two colour diagrams. The two colour approach to diagrams has not only improved the get-up of the book but will also help the reader to comprehend the diagrams much more easily.

The statements of key concepts, laws, principles and formulae have been put in bold boxes in all chapters. The exercises at the end of the chapters are really thought provoking and provide an insight into the subject of physics. Besides this, the book provides at the end not only the main subject index, but also a revision index to locate the definitions of units, statements of laws and principles, and important formulae, equations and experiments. This, again, is a useful feature of the book which will help the students in quick revision before a test, a quiz, or an examination.

The book might prove to be a good reference material for the Indian students and teachers at the high school level.

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2144

Scientific Terms

Dynamo : An electric generator especially of direct current, a device for converting mechanical energy into electrical energy. It works on the principle that if an electrical conductor moves across a magnetic field an electric current flows in the conductor. The simplest form of dynamo consists of a powerful electromagnet between the poles of which suitable conductors usually in the form of coils, called the armature, is rotated. The mechanical energy of rotation is thus converted into electric energy in the form of a current in the armature.

Electroscope : A device for detecting or determining electric charge by means of electrostatic attraction and repulsion; usually consists of two pieces of gold leaf enclosed in a glass chamber.

Ethnobotany : The branch of botany (or study of plants) which deals with the traditional folk use of plants or relation of plants to peoples and culture.

Germanium : A brittle white metal, an element, Ge. Atomic wt. 72.59; Atomic number 32, Specific gravity 5.35, Melting point 937.4°C, compounds rare ; a semiconductor, *used in transistors.*

Isotope : Any of two or more forms of a chemical element having the same number of protons or the same atomic number, but having different atomic weight (different number of neutrons). Isotopes of a particular element have almost identical chemical properties.

Onchoceriasis : Infestation of man with *Onchocera* ; adult worms encapsulated in subcutaneous connective tissue ; can cause river blindness.

Schistosomiasis : Infection of the human body by the blood fluke *Schistosoma* from drinking or bathing in infected water. *S. Haematobium* results in vesical schistosomiasis. The characteristic symptom of this disease is haemoturia. S. Mansoni and S. Japonicum produce intestinal schistosomiasis that shows diarrhoea first and liver and spleen complaints later.

Scabies : A highly contagious parasitic disease caused by the itch-mite.

Thyroid : A bilobate ductless gland found on both sides of the trachea. It secretes thyroxin, an iodinated amino acid, which controls the rate of metabolism and body growth.

Tracer : A substance, usually radioactive, which can be easily traced through a biological, chemical or physical system, (as the human body) to study the system.

Trachoma : A contagious inflammation of the conjuctiva, cornea and eyelids characterized by the formation of granulation and scarring. It is caused by *Bedsonia.* If untreated the disease may lead to blindness.

Turbine : A motor or a machine having a rotor usually with vanes or blades driven by the impact of a thrust of a moving fluid as steam, hot gas, air or water occurring as a free jet or as a fluid passing through and entirely filling a housing around the rotor.

Indian Educational Review

A Quarterly Journal of Educational Research

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SURFACE MOSAIC—Nine individual photos, taken through a violet filter from a distance of 7.8 million kilometers, were assembled for this mosaic of Jupiter. Distortions, especially noticeable at the horizon, are caused by rotation of the planet during the 96-second intervals between individual frames.

N[illegible] OF EDUCATION, RESEARCH AND TRAINING